MACHINE DESIGN

February 1949

In This Issue: **INDEXING CAMS . . . DESIGNING FOR BUTT WELDING PLANETARY GEARING . . . HOPPER-FEED MECHANISMS . . . V-BELT DRIVES**

Only EVERLOCK wide chisel edges flexed under powerful spring tension GRIP LIKE THIS!

For extra staying power, choose EverLOCK Washers. No matter how — or how often — your assemblies are subjected to vibration, strain, expansion or contraction, the many *wide chisel edges* of EverLOCK Washers combine with powerful spring tension to effectively resist every conceivable loosening action. Illustration in circle gives photographic evidence of the extra gripping area provided by each of an EverLOCK's many wide chisel edges.

Other EverLOCK advantages include (1) speed and ease of application that save time and labor; (2) elimination of all hazards of stretched bolts and distortion of threaded parts. Write for full particulars.

EverLOCK WASHERS

THE WASHER THAT HAS THE EDGE

THOMPSON-BREMER & CO., 1636 W. HUBBARD STREET, CHICAGO 22, ILLINOIS

MACHINE DESIGN

Vol. 21—No. 2 **February, 1949**

THE PROFESSIONAL JOURNAL OF CHIEF ENGINEERS AND DESIGNERS

This Month's Cover: Contacts and thermostatically controlled release mechanism for Toastmaster domestic toaster. Dashpot, shown in cutaway view, provides cushioned release of toast.

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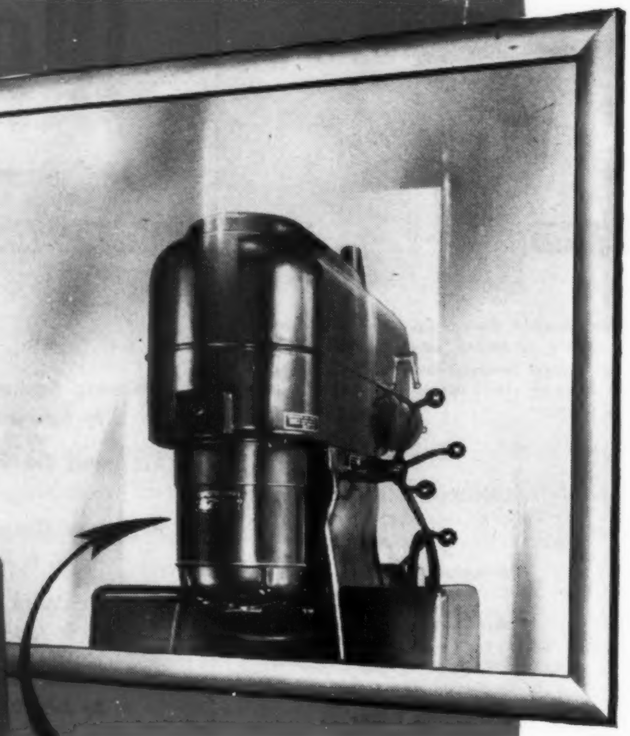


The Moore No. 2 Jig Borer, made by Moore Special Tool Co., Inc., Bridgeport, Conn.

RIGHT...

ON BOTH SPEEDS!

R & M Motors meet the Two-Speed needs of this capable Moore Jig Borer

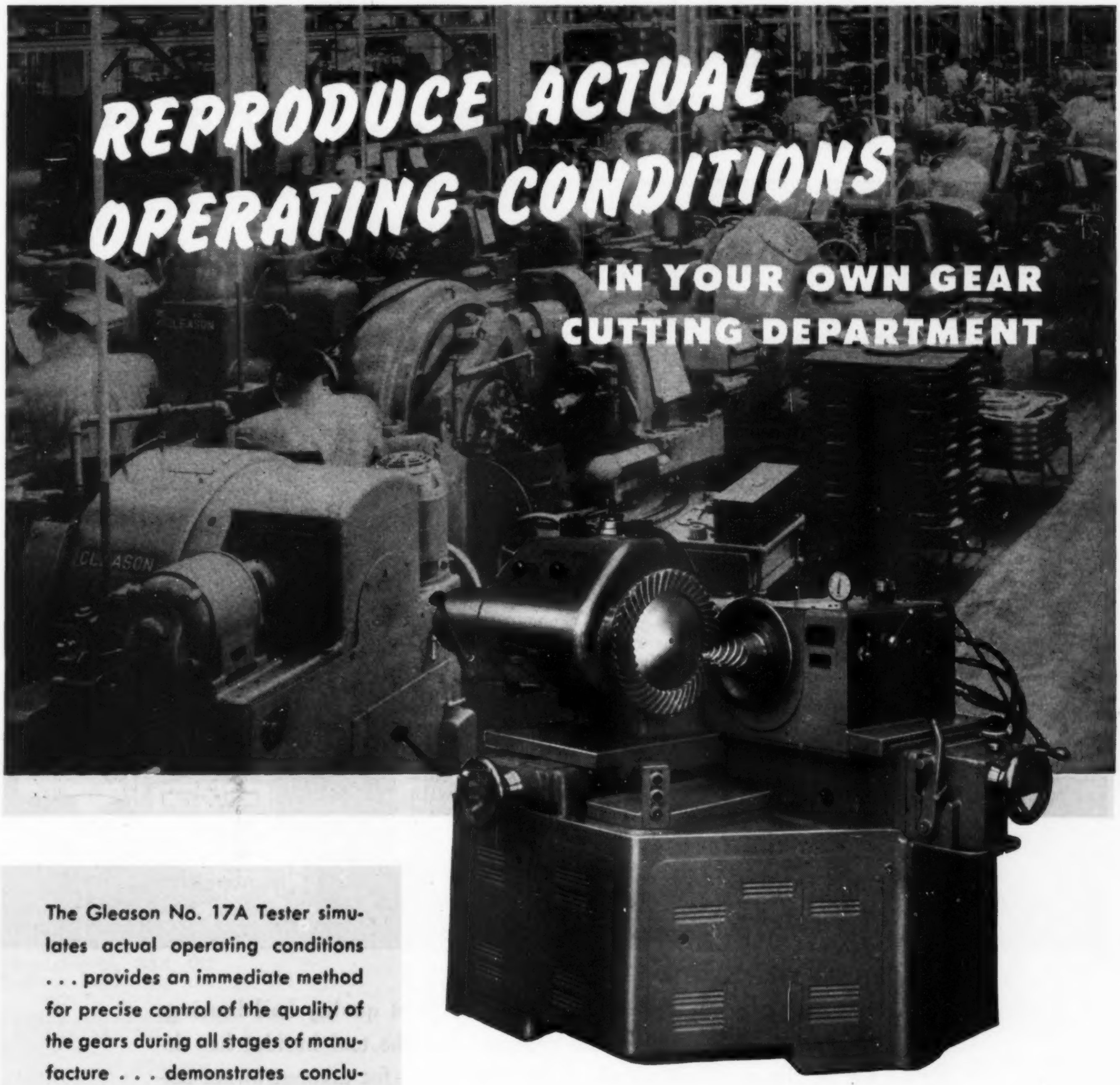
2 h.p. at 1725 r.p.m.! 1 h.p. at 850 r.p.m.! This standard two-speed Robbins & Myers motor on the Moore Jig Borer follows a high performance curve in *both ratings* with dependable fidelity. Experience in equipment-powering has *proved* to Moore engineers that R & M motors excel in every performance requirement.

PERFORMANCE PLUS... Here's proof, too, that motors need not be "*sore thumbs*" in otherwise attractive contours. This motor has standard Type C NEMA flange dimensions, and a *special head* developed by Robbins & Myers. R & M engineering-to-the-job *does* make a world of difference. Moore's Chief Engineer, F. C. Victory, says, "completely satisfied with *every aspect*—from design to motor performance."

YOURS FOR THE ASKING... You can look to Robbins & Myers for *progressive* powering ideas. Literature or truly cooperative engineering aid is yours for the asking. Address *Robbins & Myers, Inc., Motor Div., Dept. E-29, Springfield 99, Ohio.*

Good... Good Looking... Good to Use...

DEPENDABLE ROBBINS & MYERS MOTORS



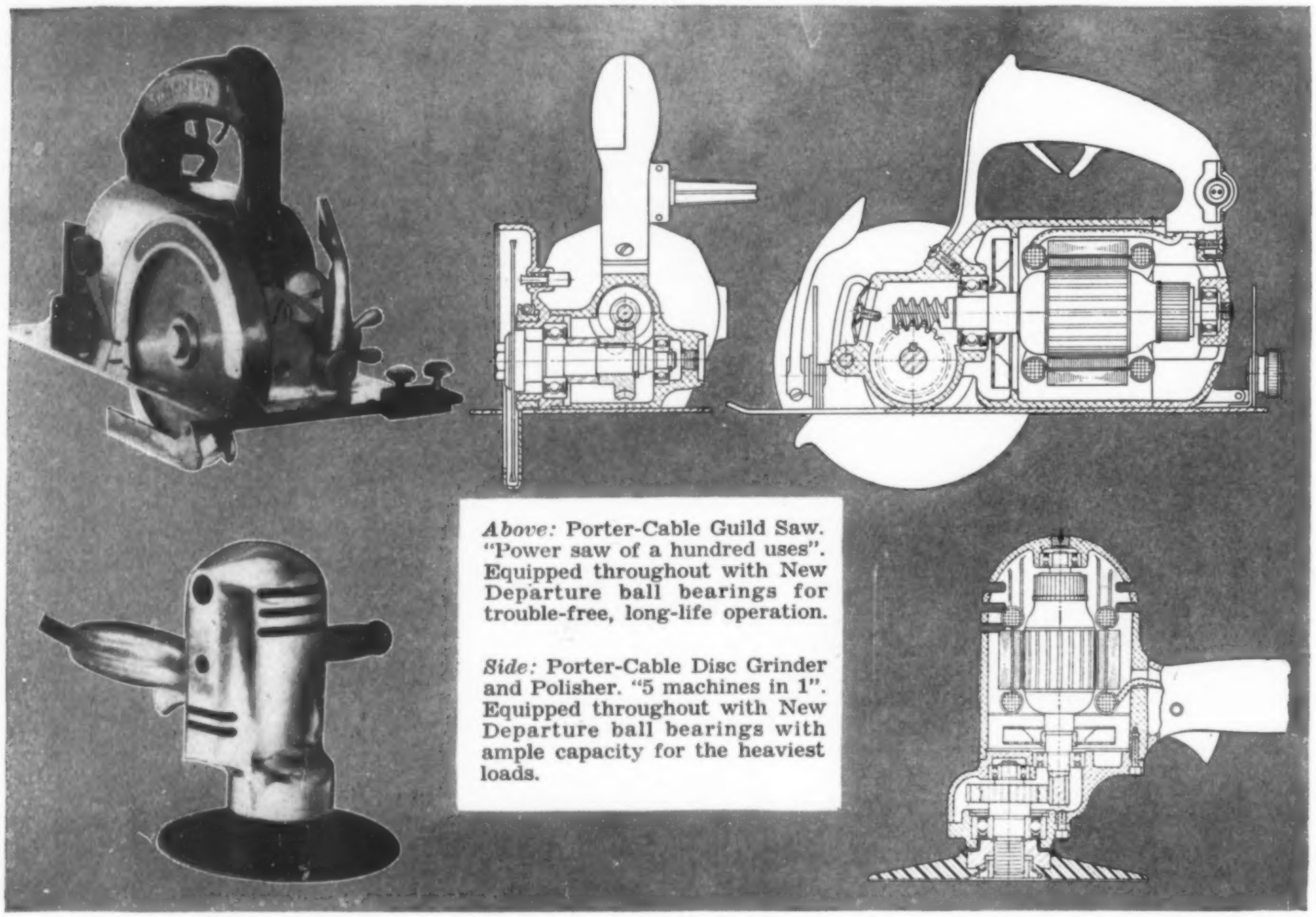
The Gleason No. 17A Tester simulates actual operating conditions . . . provides an immediate method for precise control of the quality of the gears during all stages of manufacture . . . demonstrates conclusively the gears are right before assembly. With this new hypoid tester, a running test may be given *in the Gear Cutting Department itself* with the gears correctly mounted in operating position, run under power, *as they are when mounted in final assembly* to demonstrate conclusively the smoothness and quietness of operation, the tooth bearing, tooth size, surface finish, runout and tooth spacing errors.

The **NEW No. 17A HYPOID TESTER** has a new feature for the automatic duplicating of backlash with each pair of gears being tested. Thus correct mounting may now be read simply and easily from an indicator.

GLEASON
Works
1000 University Avenue
Rochester 3, N.Y., U.S.A.

Builders of Bevel Gear Machinery for Over Eighty Years

Designed with Ball Bearings . . .
for long life . . . hard usage



Above: Porter-Cable Guild Saw. "Power saw of a hundred uses". Equipped throughout with New Departure ball bearings for trouble-free, long-life operation.

Side: Porter-Cable Disc Grinder and Polisher. "5 machines in 1". Equipped throughout with New Departure ball bearings with ample capacity for the heaviest loads.

WHEN power tool specifications read — "highest quality ball bearings throughout" — that is concrete evidence that the tool builder has designed for maximum performance — for long life — for greatest owner satisfaction.

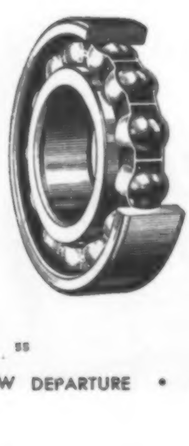
Builders of portable tools specify New Departure ball bearings because:

They hold moving parts in permanently accurate alignment.

Take all thrust and radial loads with absolute minimum of frictional loss.

Require practically no attention of any kind throughout life of tool.

Assure delivery of maximum power at point where work is done.



Nothing Rolls Like a Ball

NEW DEPARTURE

BALL BEARINGS

55

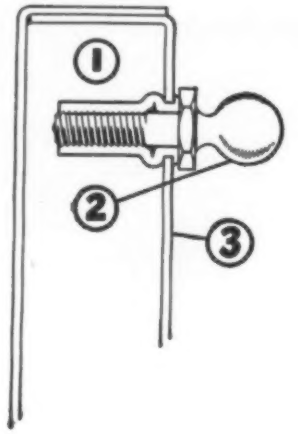
NEW DEPARTURE • Division of GENERAL MOTORS CORPORATION • BRISTOL, CONNECTICUT • BRANCHES IN ALL PRINCIPAL CITIES

Itemized Index

Classified for convenience when studying specific design problems

MACHINE DESIGN is indexed in Industrial Arts Index and Engineering Index Service, both available in libraries generally.

3 tough fastening problems solved by one RIVNUT!

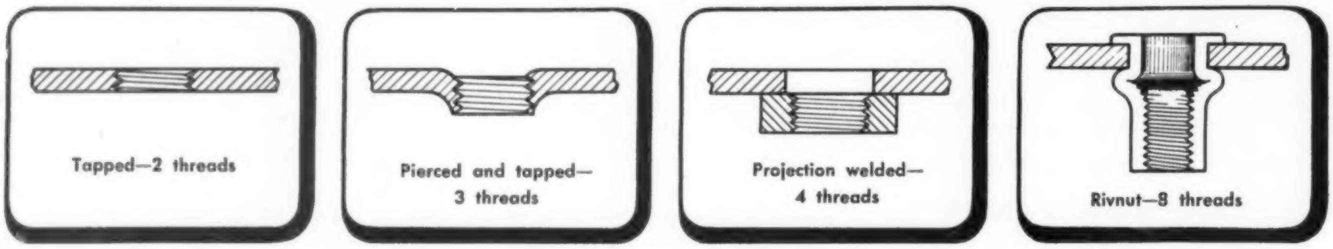


KITCHEN CABINET designers needed a rivet that 1) could be installed from one side only, 2) would serve as a nut plate for a knob attachment, and 3) could be installed *after* enameling. A B. F. Goodrich Rivnut proved the perfect answer.

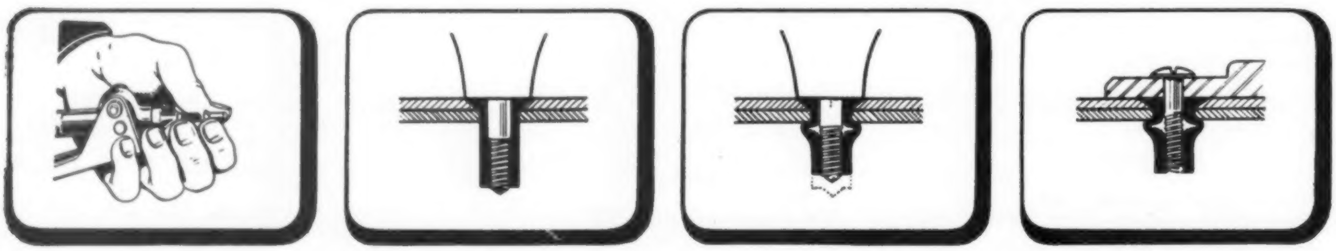
A flat-head Rivnut was inserted in the enameled sheet metal door, and upset with an easy-to-operate heading tool. The knob of the catch was then threaded into the clean, still-intact Rivnut threads.

This simple solution saved many man-hours on this job. If you have a fastening problem, why not put it up to Rivnut engineers? Write to The B. F. Goodrich Company, Dept. MD-29, Akron, O.

Compare these 4 methods of putting screw threads in thin sheet metal



Rivnuts provide 8 clean threads in one simple operation!



1. Rivnut is threaded onto pull-up stud of a manual or pneumatic heading tool.

2. Rivnut is inserted—head firmly against work, tool at right angles to work.

3. Tool lever operates pull-up stud, forming a bulge in the Rivnut shank.

4. After upset, Rivnut threads are still clean and intact ready for screw attachment.

B.F. Goodrich

RIVNUTS

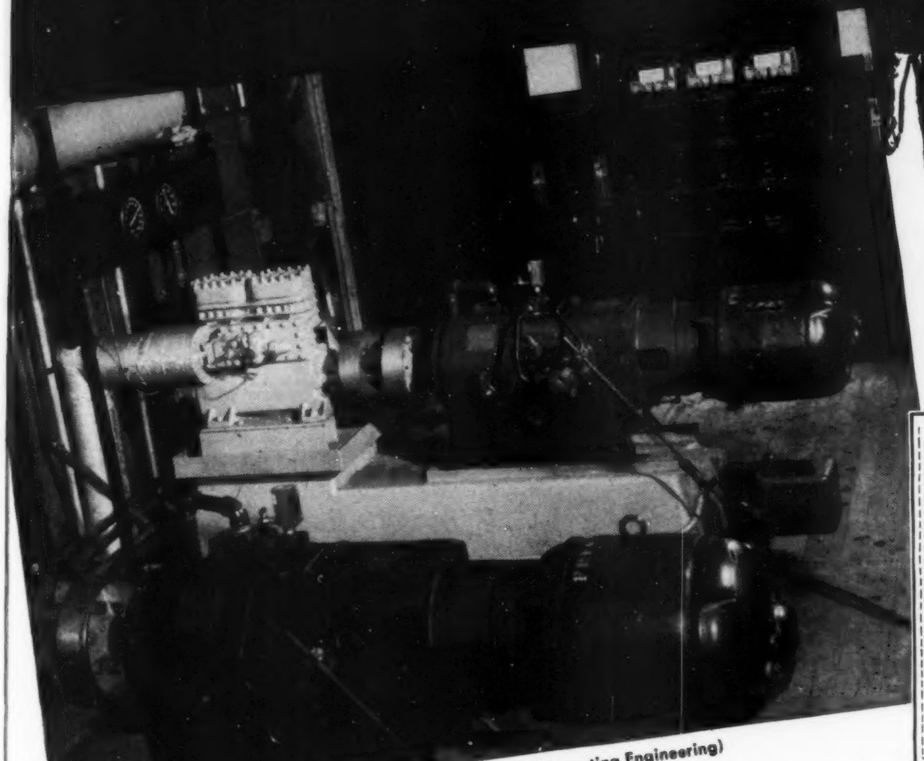
The only combination rivet and nut plate

HOW AND WHERE TO USE RIVNUTS

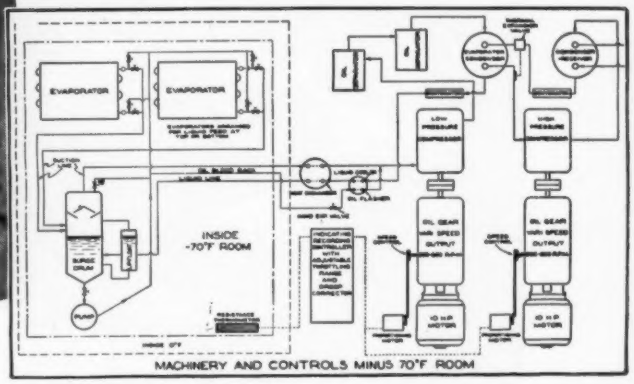
Just off the press! New edition tells how to install Rivnuts. Includes facts on new heading tools, test data. Gives types, sizes and grip ranges. For your free copy, write to the B. F. Goodrich Company, Dept. MD-29, Akron, Ohio.

A STEADY *102°* BELOW FREEZING

... CALLED FOR CONTINUOUSLY VARIABLE SPEEDS AND STABLE OUTPUT TORQUE



Two Oilgear Fluid Power Transmissions driving compressors for research laboratory's −70 degree testing room. (Other Oilgear Transmission drives compressor for 0 degree room.) Output speed of transmissions varies according to temperature differential upon resistance thermometers. Control of speed is entirely automatic. Manual control for starting is optional. Oilgear Fluid Power Drives and compressors operate continuously. (See schematic below).



MACHINERY AND CONTROLS MINUS 70°F ROOM

(Photo and Schematic from Refrigerating Engineering)

OILGEAR *Fluid Power* SOLVED THIS PROBLEM

Trademark Reg U S Pat Off

The wide range of installations that demonstrate the reliability, scope and ease of control of Oilgear Fluid Power Drives and Transmissions grows daily. A case history from REFRIGERATING ENGINEERING, official journal of the American Society of Refrigerating Engineers, telling how a research laboratory chose Oilgear Transmissions and obtained continuous, dependable performance without delay, is another chapter in that story.

Demands for tests of materials at extreme temperatures called for equipment able to hold testing room temperatures stable at all times—usually at 70° F. below zero. It also had to refrigerate test materials as rapidly as possible. This meant a system of varying compressor speeds automatically—so as to compensate for variations in heat load.

Previous experience had shown that . . . the use of direct current motors, or variable speed drives of the belt-and-pulley type, under automatic control, was not entirely reliable and required considerable servicing.

Then Oilgear Fluid Power Transmissions were adopted. These transmissions provide continuously and automatically variable output speed and maximum output torque at all operating speeds. Nearly two years' experience reveals that temperatures have been maintained within ±½° F. of the desired figure over long periods of time, that no attendant is required except for a few minutes' daily routine inspection, that the Oilgear drives are completely reliable.

Thus the evidence grows that if you are tired of machine or process drives and transmissions that don't stand up, if you want simpler, better, more productive and dependable drives, if you have problems not yet solved, it will pay you to contact Oilgear Fluid Power engineers. THE OILGEAR COMPANY, 1568 W. Pierce St., Milwaukee 4, Wis.

Oilgear Fluid Power

DO YOU HAVE A PROBLEM IN PIPE ALIGNMENT?

Here's how BARCO solves it in a mud pump

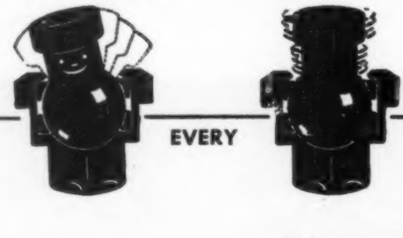
Barco ball joints are used on this mud pump in the oil fields. Because of their flexibility, Barco Joints take care of piping misalignment caused by the pump settling. They also facilitate quick break-down and setting-up of drilling rig equipment.

This is one of the many, many applications of Barco Joints in practically every field of industry and transportation. By responsive movement through every angle, Barco absorbs strain and stress, compensates for expansion and contraction. The invaluable experience of Barco's engineering department is available to you in solving your own particular problem. Write Barco Manufacturing Company, 1806 Winnemac Avenue, Chicago 40, Illinois. In Canada: The Holden Co., Ltd., Montreal, Canada.

BARCO *FLEXIBLE JOINTS*

Not just a swivel joint ...but a combination of a swivel and ball joint with rotary motion and responsive movement through every angle.

FREE ENTERPRISE—THE CORNERSTONE OF AMERICAN PROSPERITY



"MOVE IN EVERY DIRECTION"

BALDOR MOTORS

Are Sold and Serviced *Nationally*

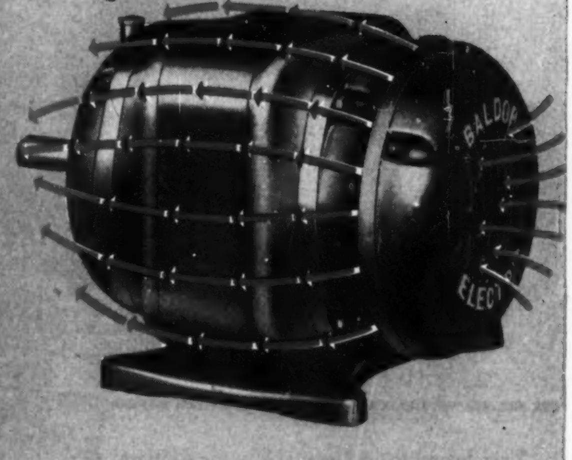
Dots indicate approximate location of over 200 Baldor Motor Authorized Service Dealers.

BALDOR STREAMCOOLED MOTORS
are 100% totally enclosed

. . . they not only serve applications where totally enclosed motors are necessary but they also provide complete protection where dust-proof, drip-proof, splash-proof and vermin-proof motors are essential.

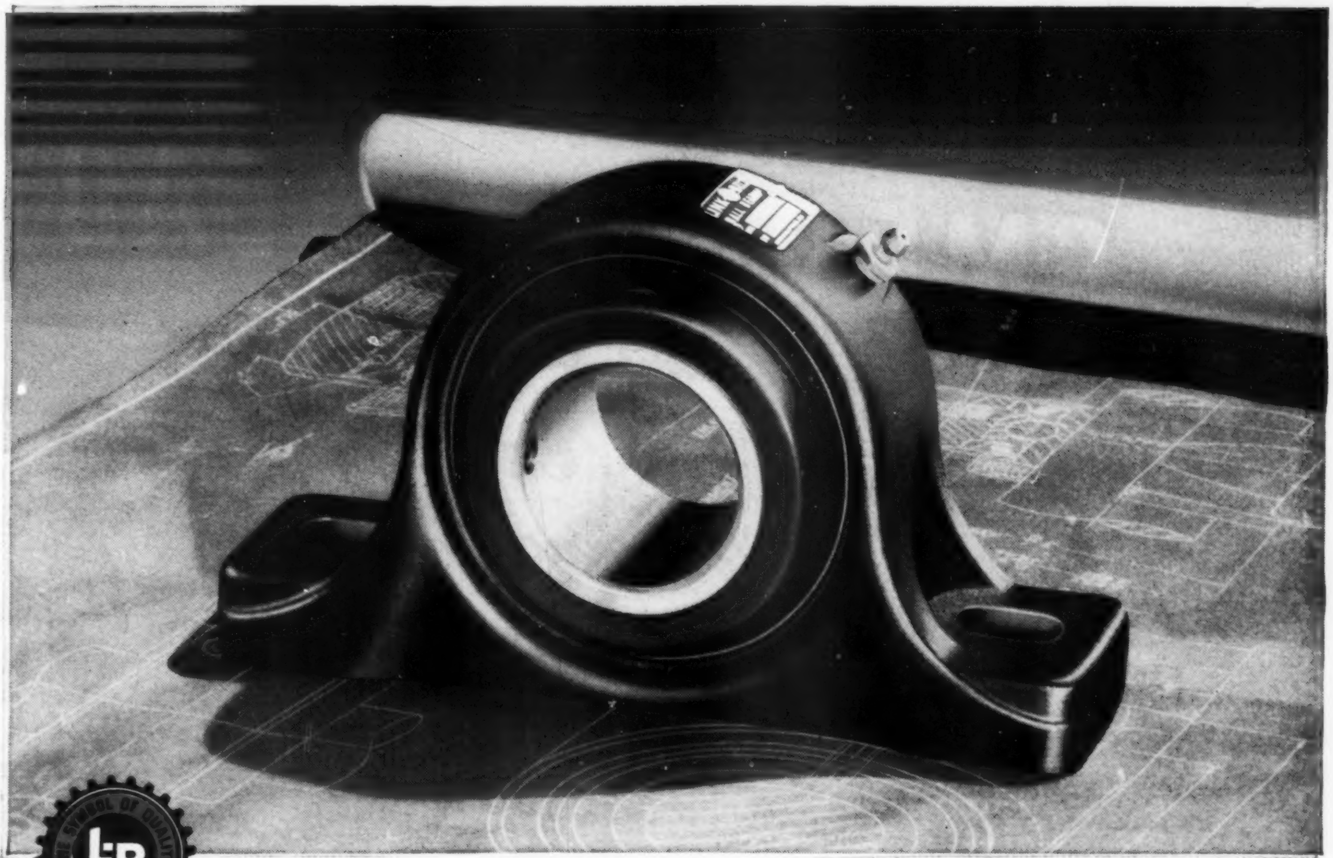
These motors are sold and serviced nationally in more than 200 trade centers.

BALDOR ELECTRIC CO. • St. Louis
(District Offices in Principal Cities)



Baldor Streamcooled Motors cannot inhale dust, dirt, lint or foreign matter because they are totally enclosed . . . non-clogging and cool-operating . . . because the outer-mounted fan forces air over the ENTIRE EXTERIOR of the motor.

Baldor
BETTER MOTORS
FOR MORE THAN A QUARTER OF A CENTURY



REX TABLE TOP CHAIN

puts Plus Performance in your designs

If you're designing fillers, cappers, labelers, washers, pasteurizers or machines handling small parts or packages, Rex Table Top Conveyor Chain can help you design-in smooth, steady product movement. Here's why!

TABLE TOP ELIMINATES PILE-UPS AND SPILLAGE. The exclusive, hinged joint construction assures a constant carrying surface. There is no continuous gap across the width of the links as the chain flexes over sprockets to catch and trip containers. Accurately beveled edges allow smooth transfers . . . permit the chain to slide freely from under blocked containers. And Table Top will not tear paper cartons.

TABLE TOP HAS A SIMPLIFIED DESIGN. A one-piece platform link of case-hardened or stainless steel and a husky rivet is all there is to Table Top. There are no attachments or rivets to "loosen" or "wobble." Fewer parts mean greater steadiness, less chance for breakage, greater all-round efficiency.

TABLE TOP LASTS LONGER. The entire Table Top link absorbs the pulling load. Sprocket tooth bearing pressure is spread over the entire length of the joint not concentrated on a small area. This feature alone accounts for a great part of Table Top's longer service life.

TABLE TOP STAYS CLEANER. There are no pockets on Table Top to catch and hold foreign matter. It's easy to clean . . . easy to keep clean. When cleaning is necessary, a jet of water or steam does the job in a hurry.

Many sizes of Table Top are available for immediate delivery. For all the facts, send for your copy of Bulletin No. 47-15. Chain Belt Company, 1643 West Bruce Street, Milwaukee 4, Wisconsin.

CHAIN BELT REX COMPANY

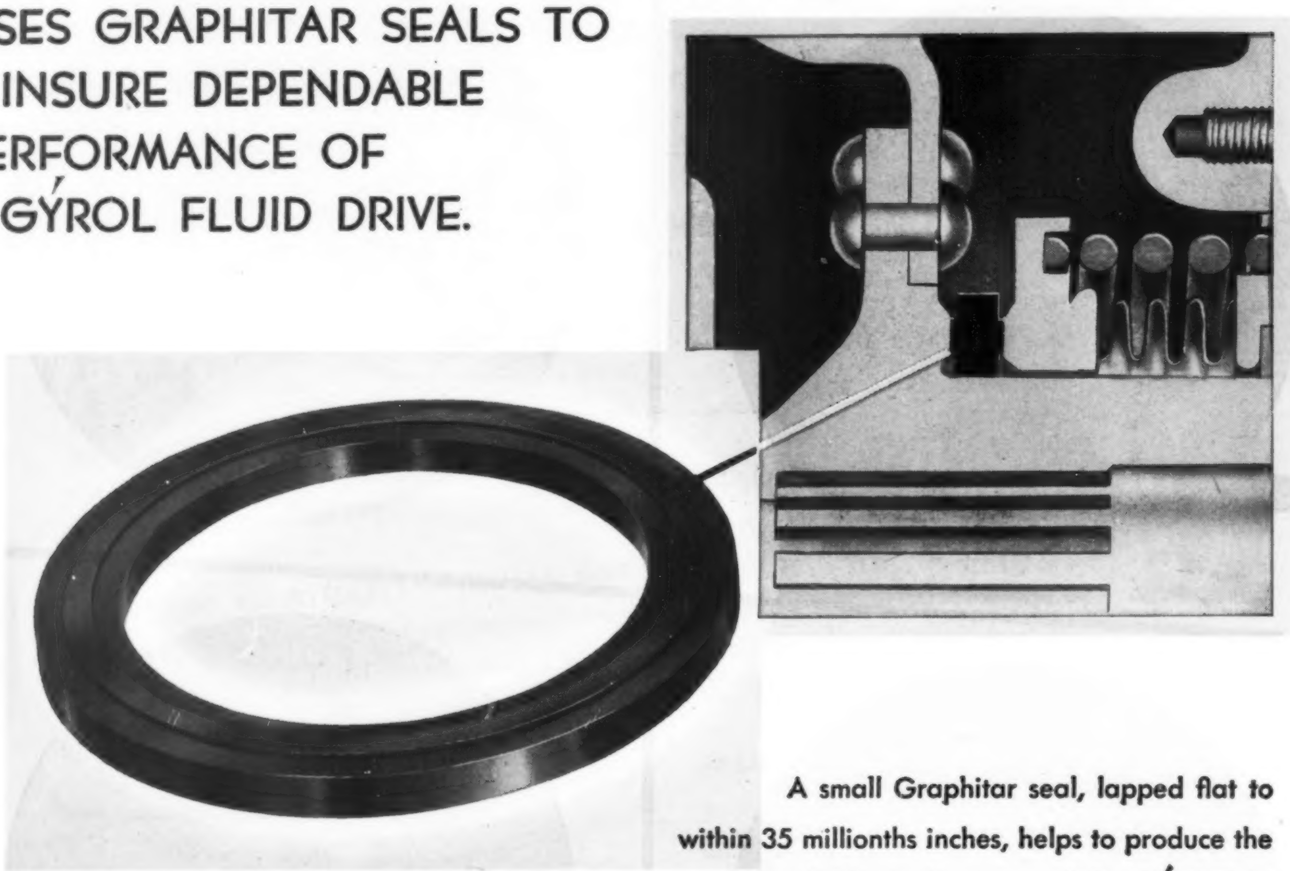
DRIVE AND CONVEYOR CHAINS

graphitar seal helps

(CARBON-GRAPHITE)

# of gýrol fluid drive unit

AMERICAN BLOWER CORPORATION
USES GRAPHITAR SEALS TO
INSURE DEPENDABLE
PERFORMANCE OF
GÝROL FLUID DRIVE.



A small Graphitar seal, lapped flat to within 35 millionths inches, helps to produce the dependable performance of the Gýrol Fluid Drive manufactured by American Blower Corp. Installed as shown, the Graphitar seal floats free, seals with no leakage whatsoever, and requires no lubrication because its carbon-graphite composition is self-lubricating. This seal, like all Graphitar parts, affords maximum resistance to friction and wear, it is mechanically strong and it is unaffected by chemical attack and sudden and extreme temperature changes. In similar installations, Graphitar seals assure efficient sealing where operating conditions include pressures up to 60 lb./sq. in. at 350°F. and 1000 ft./min., and temperatures up to 550°F.

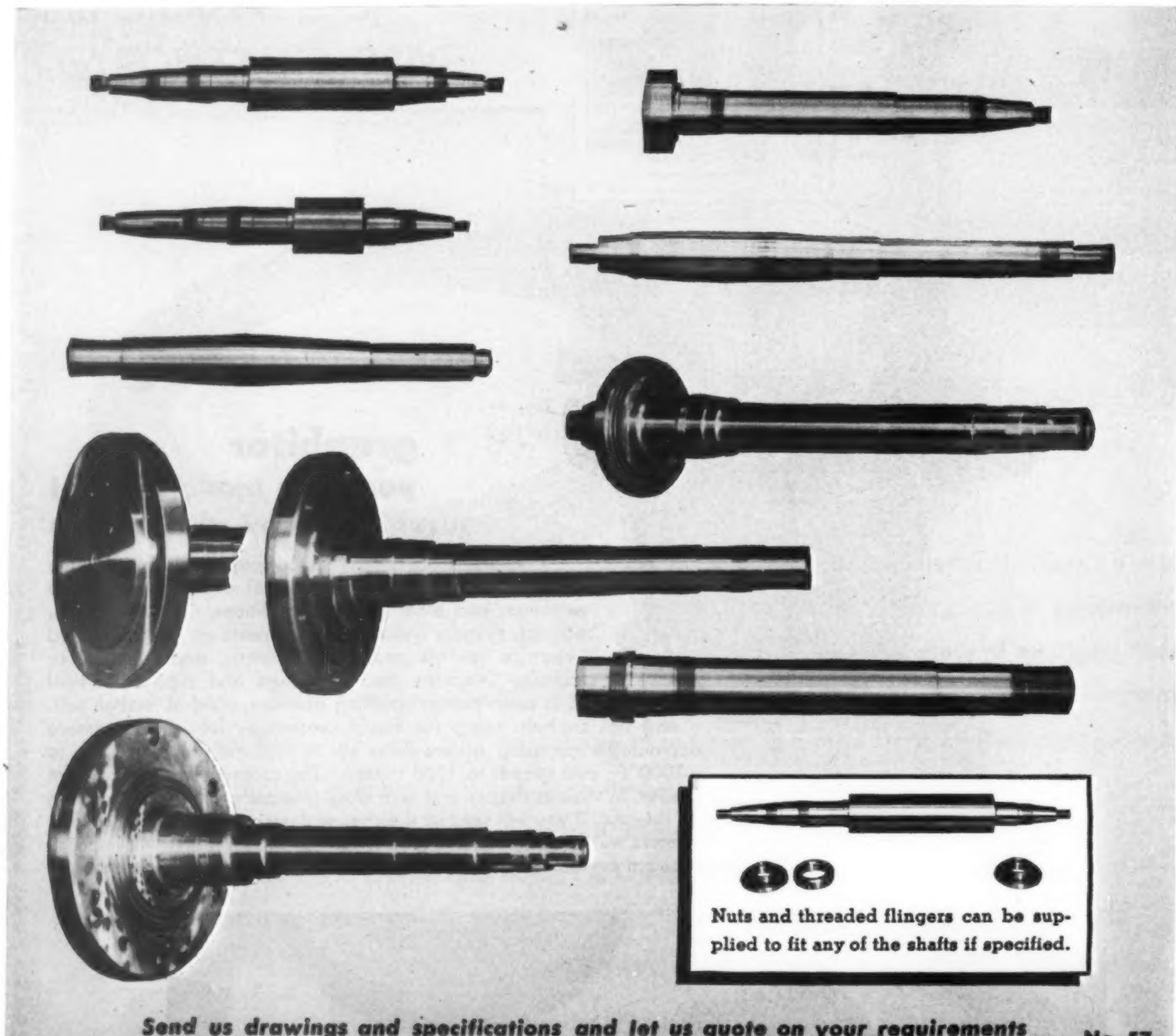
THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

POPE

PRECISION SHAFTS

We are now in a position to supply precision shafts made to your own designs and specifications as to material and tolerances, with ground threads and dynamically balanced if required.



Send us drawings and specifications and let us quote on your requirements

No. 57

POPE

TRADE MARK REG. U.S. PAT. OFF.

POPE MACHINERY CORPORATION

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FREE . . 4-page catalog-bulletin illustrating many different types and applications of G. S. Small Gearing. It may offer valuable suggestions and ideas that you can use. Write today

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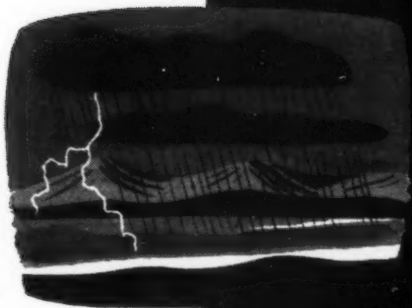
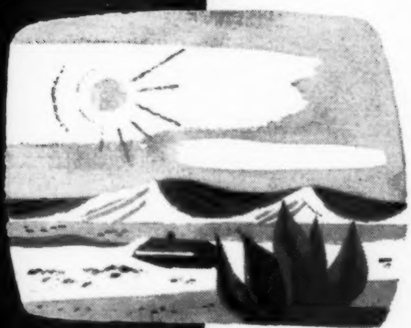
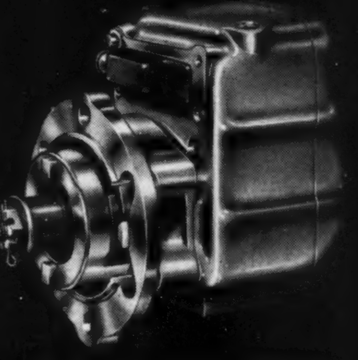
When Old Style Magnetos Give Up... BENDIX-SCINTILLA H TYPE MAGNETOS...

Base Mounted H-Type Magneto







Flange Mounted H-Type Magneto

*TRADEMARK

Just Keep Sparking Along!

Dependability isn't something seasonal—it's a year around proposition and there are no short cuts in building it into engines. Specifying component parts you know will stand up under all operating conditions is the *only* answer! Ignitionwise, no magneto of its type will out-perform or out-last the Bendix-Scintilla* H Magneto. Our long experience in building ignition equipment for the vast majority of aircraft engines is reflected in this magneto for one-cylinder engines. Include the Bendix-Scintilla H-Type Magneto in your specifications. For further details, see your distributor or write the factory direct.

OUTSTANDING FEATURES YOU'VE ASKED FOR

- Waterproof coil
- Waterproof, high-tension outlet
- Higher voltage at starting speeds
- Constant spark over entire speed range
- Equipped with impulse coupling
- Compact and sturdy construction

SCINTILLA MAGNETO DIVISION of

Bendix AVIATION CORPORATION

BENDIX SCINTILLA

SIDNEY, NEW YORK

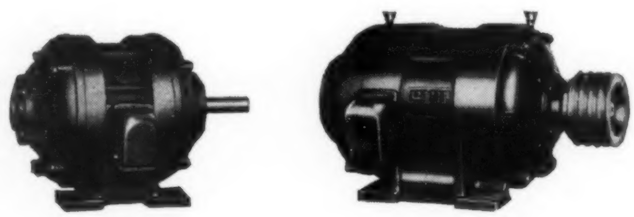
Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.

ALLIS-CHALMERS OFFERS EQUIPMENT

Looking for

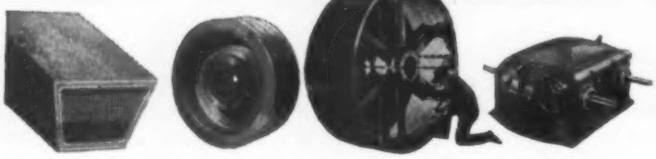
ENCLOSED NON-VENTILATED motor for dusty, non-explosive atmospheres. Ratings from 1 to 1½ hp.

Specify Allis-Chalmers . . . for quality backed by 50 years of motor building . . a century of manufacturing experience. Motors from ½ HP to any size . . . and a nation-wide certified service program to *keep* your motors running!



GENERAL PURPOSE motor handles 90% of all alternating current motor requirements. Ruggedly constructed with distortionless rotor. Sizes from 1½ to 200 hp.

ENCLOSED FAN-COOLED motor for use in dusty atmospheres where danger of explosion does not exist. Suitable for outdoor use. Sizes from ½ to 200 hp.

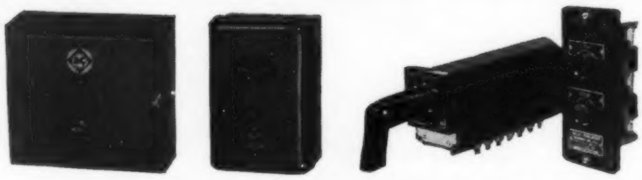


Special Sheaves

Super-7 V-Belts   *Magic-Grip Sheaves*   Speed Changers

Texrope V-Belt Drives

Fastest delivery in industry on standard V-Belt sizes and lengths. Constant speed drives include complete line of *Texiron, Texsteel, Texdrive, Magic-Grip,* standard cast iron and steel sheaves for section A, B, C, D, and E belts. For adjustable speed, Vari-Pitch sheaves give speed range of 100% per sheave, *Vari-Pitch* speed changers 375% range.



Motor Starters   Rotary Control and Push Buttons

Controls — Any Type or Size

Across-the-line starters for a-c motors range from size 0 to 7. Manual or magnetic, full or reduced voltage starters for any industrial application. Standard, dust-tight, water-tight, and expiosion-proof enclosures. Standard and heavy duty push button stations, rotary switches, voltage regulators, contactors and relays.

Sold — Applied — Serviced by Authorized Dealers, Certified Service Shops, and District Offices Throughout U. S.

ALLIS-

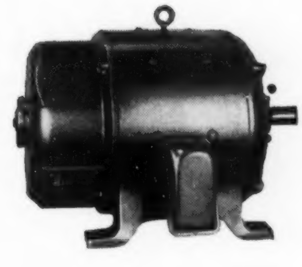
AID TO MACHINE DESIGNERS!

Quality Motors?

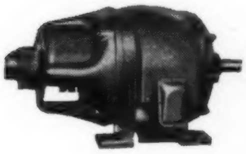
VERTICAL MOTOR TYPE ARV. Available in open, enclosed, fan-cooled, splash-proof, and explosion-proof types. Ratings from 1½ to 200 hp, 25, 50, and 60 cycles.

EXPLOSION-PROOF approved by Underwriters for Class I, Group D, and Class II, Group G locations. Safe in atmospheres containing gasoline, etc. ¾ to 200 hp.

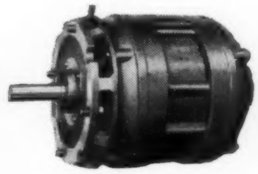
SPLASH-PROOF excludes top or side directed particles or liquids. Squirrel cage type with anti-friction bearings. Available in ratings from 1½ to 200 hp.



DIRECT CURRENT motors for adjustable speed and continuous reversing drives. Furnished in open, drip-proof, splash-proof and other modifications. ½ to 200 hp.



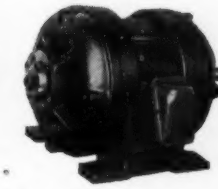
WOUND ROTOR motor for use where high starting torque and low starting current is required . . . also for adjustable speed drives. Open, splash-proof and enclosed. ½ to 200 hp.



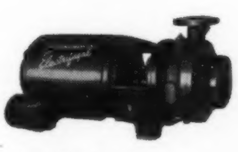
SIDE OR ANGLE mounting motor in open, enclosed fan-cooled, splash-proof and explosion-proof types. Ratings from 1½ to 75 hp. Normal or high starting torque windings.

GEARMOTORS for low-speed drives give speeds from 7.5 rpm to 780 rpm using 1750 rpm motor. Class I, II, and III gears. All motor and Integral types. 1 to 75 hp.

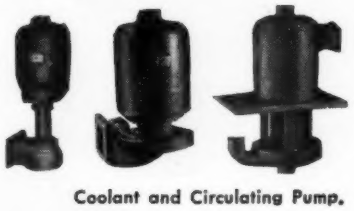
GENERAL PURPOSE in ratings from 1 to 7½ hp. Here's a small, tough, squirrel-cage motor with anti-friction bearings. Normal or high starting torque, normal or low starting current.



MULTI-SPEED SQUIRREL CAGE motors in constant torque, variable torque, and constant horsepower types. Two or four speeds. Sizes range from ⅛ to 75 hp. Speeds 450 to 3600 rpm.



Electrifugal Pump.



Coolant and Circulating Pump.

Pumps — 10 to 10,000 gpm

Electrifugal pumps have bracket and flange cast integral with motor frame. This insures perfect alignment of pump and motor. Use for general purpose pumping from 15 to 1600 gpm — heads to 180 ft. — motors from ¾ to 25 hp. Complete line of coolant and circulating pumps are now available for quick delivery.

Electrifugal, Texrope, Super-7, Texiron, Texsteel, Texdrive, Magic-Grip and *Vari-Pitch* are Allis-Chalmers trademarks.

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Please send me:

- ☐ Handy Guide to Electric Motors (51B6052H
- ☐ Handy Guide to Centrifugal Pumps (53B6059D)
- ☐ Handy Guide to Texrope Drives (20B6051H)
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- ☐ Equipment for Machine Tools (25B7110)
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There's room for your flat work too!

Turning out plain and fancy flat springs and small stampings is a big share of our daily work. Ingenuity with special dies and versatility in the treatment of spring steel in our own mill results in a better product that wins and holds users who rate quality and workmanship high.

For a quotation—or a place on our production schedule—send your inquiries, accompanied by samples and/or complete specifications.

Wallace Barnes SPRINGS

SMALL STAMPINGS • WIRE FORMS • HAIRSPRINGS • COLD ROLLED SPRING STEEL

WALLACE BARNES COMPANY
BRISTOL, CONN.

DIVISION OF THE ASSOCIATED SPRING CORP.

AND IN CANADA, THE WALLACE BARNES CO., LTD., HAMILTON, ONTARIO

Perhaps our conservative attitude towards metal powder applications has discouraged many manufacturers from making use of powder metallurgy.

Naturally, we're sorry about this. But our established realistic policy of taking only the kind of business that results in lasting satisfaction for the customer remains unchanged.

We'd still rather lose an order than speculate with a manufacturer's time and money on the mere chance that powder metallurgy might work for him.

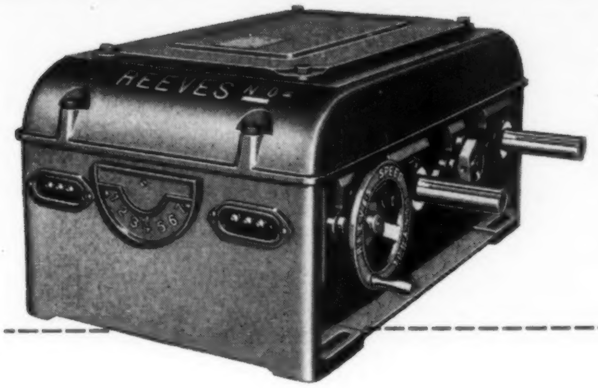
That's why we consistently emphasize the requirements for practical metal powder parts production. That's why we tell you that we can't honestly begin to accept your business unless the parts you need fulfill these conditions: (1) The shape permits good die fill and proper density; (2) the order is sufficiently large to justify initial tooling costs; (3) the physical properties and tolerances required are within the range obtainable in normal factory production.

MORAINE PRODUCTS

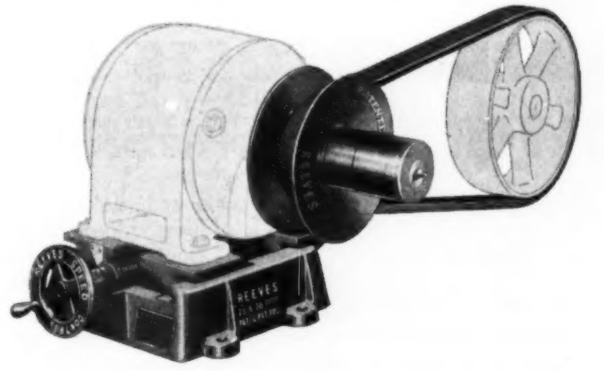
DIVISION OF GENERAL MOTORS DAYTON, OHIO

METAL POWDER PARTS . . . BY MORAINE

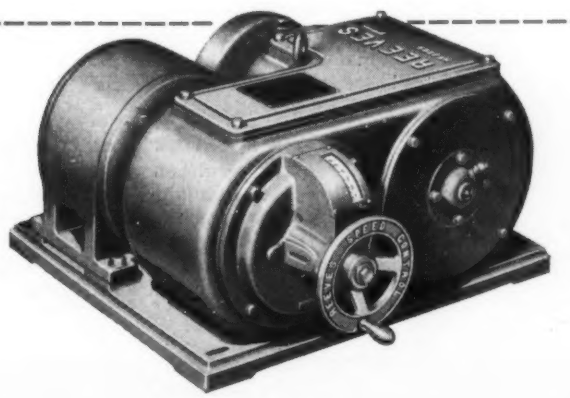
-that's why Reeves gives you a choice of 3*



* **Transmission** (left), extremely rugged in construction, is especially desirable for installations where the demand is for heavy-duty service, higher horsepower output, wide speed range, automatic control, etc. "Internal operating parts" ideal for incorporation within the machine framework as standard equipment. Transmission provides infinite, accurate speed flexibility over a range of 2:1 to 16:1. Sizes—fractional to 87 hp.



* **Motor Pulley** (right), most practical in installations calling for economy, limited speed range, ease of installation, low horsepower output, etc. Provides an instantly variable speed drive within 4:1 ratio for any constant speed motor. Sizes to 10 hp.



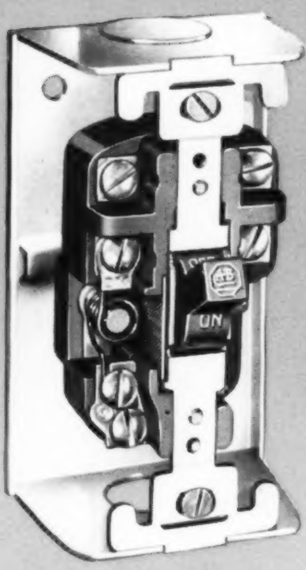
* **Motodrive** (left), ideal for installations indicating compactness, low output speeds, etc. Combines motor, speed varying mechanism and reduction gears in single unit. Speed variations 2:1 to 6:1 inclusive. Sizes to 20 hp.

Recognized Leader in the Specialized Field of Speed Control Engineering

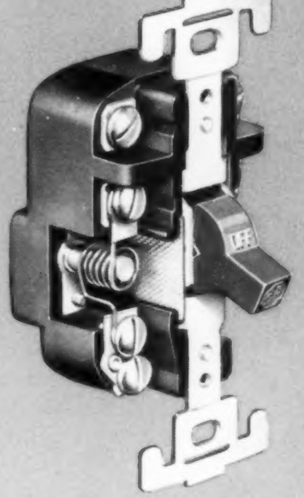
ACCURATE • VARIABLE

Reeves Speed Control

GIVES THE RIGHT SPEED FOR EVERY JOB!

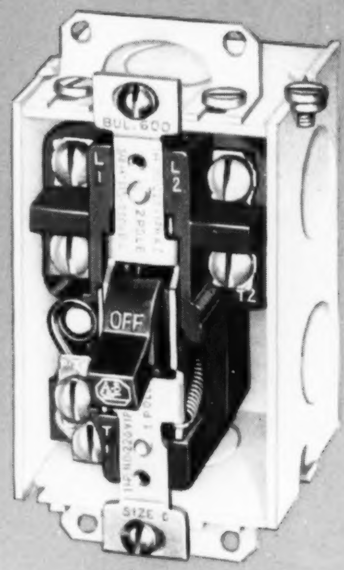


Open view of enclosure for surface mounting.



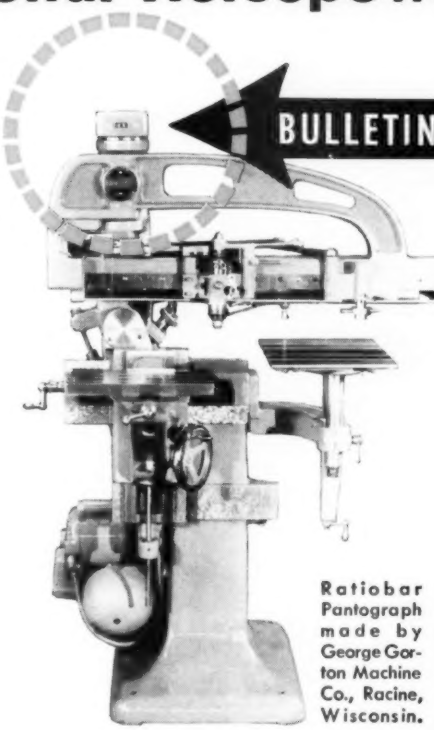
Switch unit without enclosure for machine bases.

Closed view of enclosure for surface mounting.



Bulletin 600 Switch fits into any standard switch box.

Starting Switches with Overload Protection for Fractional Horsepower Motors



BULLETIN 600 STARTING SWITCH

Ratiobar Pantograph made by George Gorton Machine Co., Racine, Wisconsin.

To satisfy the latest ruling of the National Electrical Code . . . which requires overload protection for many fractional horsepower motor applications . . . the Bulletin 600 Starting Switch is the popular answer.

Its self-contained thermal breaker is always dependable. Long periods of inactivity will not affect its accuracy. At the first sustained overload... the switch trips...and the motor is protected against burnout.

Waterproof Enclosure.

The Bulletin 600 Starting Switch cannot be held closed until the overload condition is corrected. This compact control unit is a sales asset to any machine.

Above is shown how easily the Bulletin 600 Fractional Horsepower Starting Switch fits into the standard Allen-Bradley enclosure or into any standard switch box.

The switch unit can also be mounted in any suitable cavity in the machine frame.

For locations requiring enclosures to operate in wet or hazardous locations, there are several standard A-B enclosures to meet every service requirement.

Bulletin 600 Switches are available with pilot lights, selector switches, and other accessories. Send for complete data, today.

ALLEN-BRADLEY

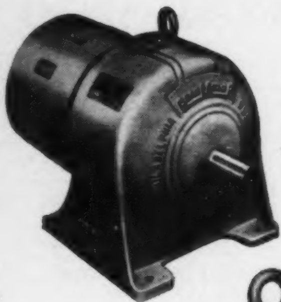
QUALITY

BULLETIN 600 STARTING SWITCHES

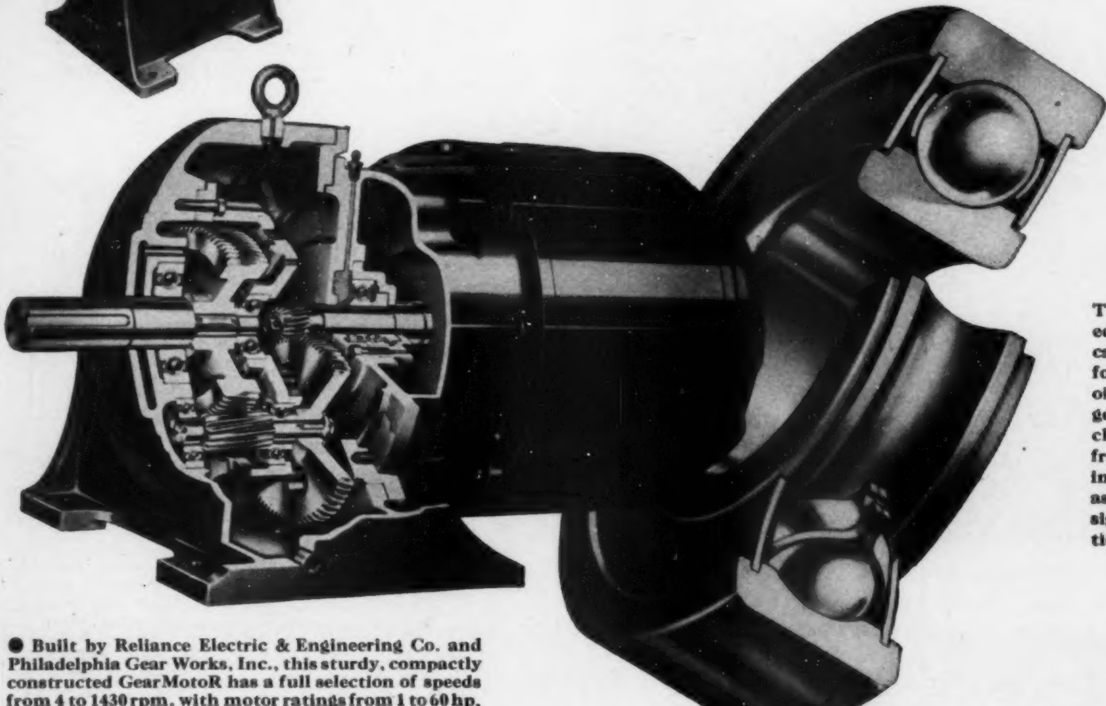
A-B Quality

Allen-Bradley Co.
1316 S. Second Street
Milwaukee 4, Wis.

How Radial and Thrust Loads are Carried



in the RELIANCE GEARMOTOR



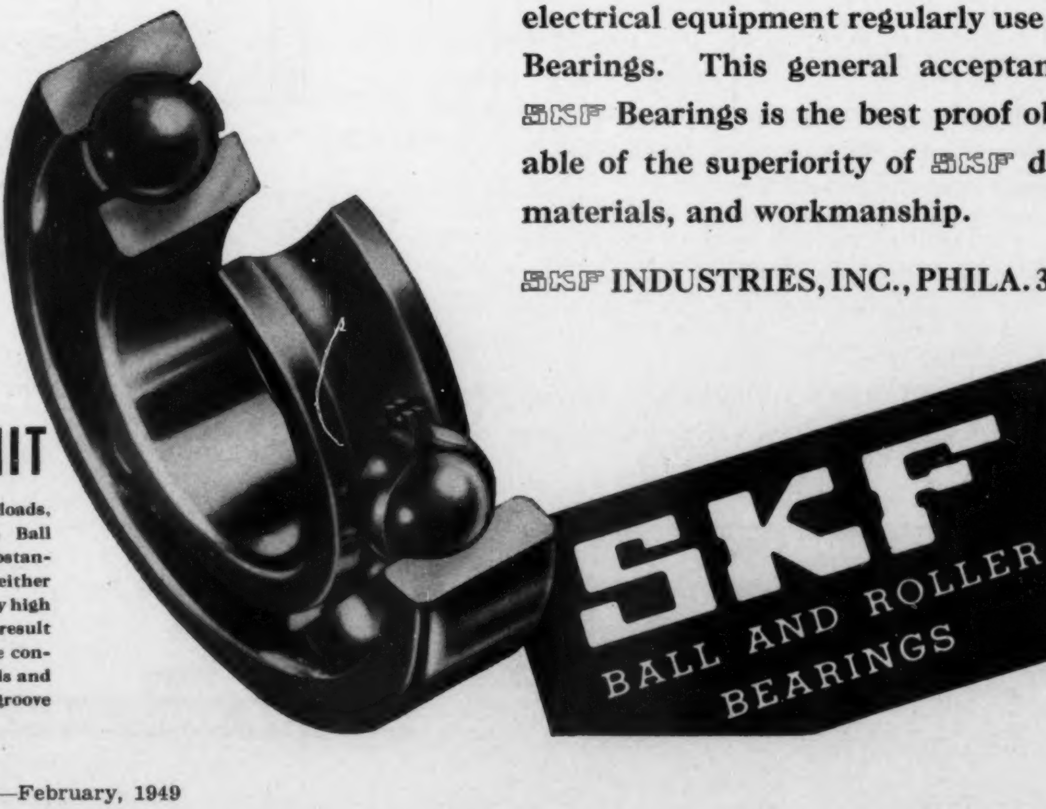
In the MOTOR

Two SKF double-shielded ball bearings are lubricated by grease, and, therefore, are independent of the oil lubricating system of the gear unit. Labyrinth enclosures prevent grease from reaching motor windings. The Reliance bearing assembly and housing design provide proper lubrication and longer bearing life.

● Built by Reliance Electric & Engineering Co. and Philadelphia Gear Works, Inc., this sturdy, compactly constructed GearMotoR has a full selection of speeds from 4 to 1430 rpm. with motor ratings from 1 to 60 hp.

Manufacturers of all kinds of rotating electrical equipment regularly use SKF Bearings. This general acceptance of SKF Bearings is the best proof obtainable of the superiority of SKF design, materials, and workmanship. 6505

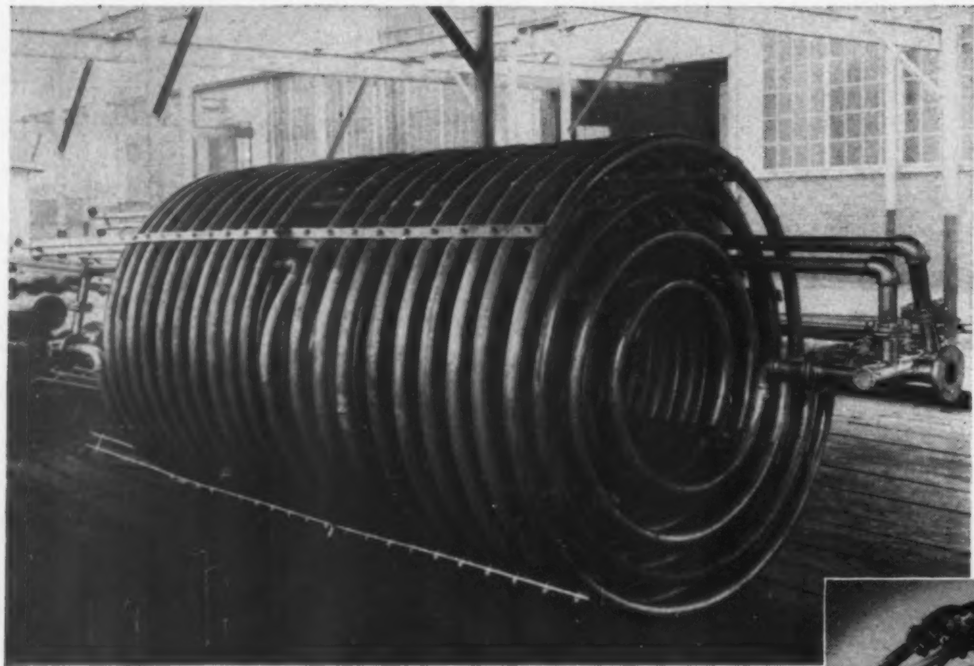
SKF INDUSTRIES, INC., PHILA. 32, PA.



In the GEAR UNIT

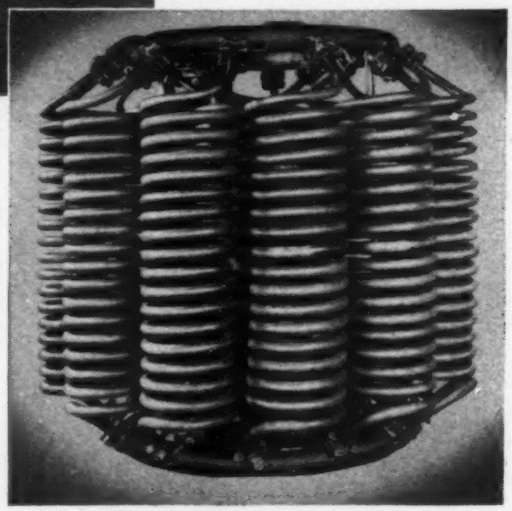
In addition to radial loads, SKF Deep-Groove Ball Bearings sustain substantial thrust loads in either direction, even at very high speeds. This is the result of the large intimate contact between the balls and the deep, continuous groove in each ring.

Why CRANE-fabricated pipe coils are the finest available



ONE SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY

Unusual assembly *of Multiple Cylindrical Pipe Coils. Fabricated header specially designed for terminal connections.*



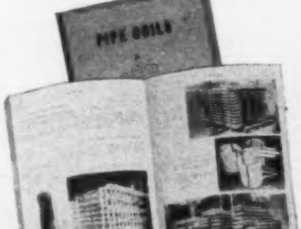
17 pipe coils in one—*completely fabricated by Crane.*

The explanation is simple enough. Crane is the world's foremost designer and fabricator of industrial piping equipment. Five Crane Shops, strategically located throughout the country, offer you the special facilities needed for fabricating pipe coils to precise requirements.

No pipe coil design is ever too large or small . . . or too complex . . . for Crane Shops to handle. Skilled manpower and superior equipment combine to assure efficient fabrication of practically every size, shape and type of tubular material.

Pipe coils of uniform accuracy and quality are as near to you as your Crane Branch or Wholesaler. You get complete local service. Talk it over with your Crane Representative.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas



Ask your Crane Man *for Pipe Coil Catalog 318—48 pages of helpful information for pipe coil specifiers and buyers. Includes diagrams of all common pipe coil designs with dimensions, and gives valuable engineering data on pipe coil materials and applications.*

EVERYTHING FROM . . .

VALVES
FITTINGS
PIPE

CRANE

PLUMBING
AND
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FOR EVERY PIPING SYSTEM

FOR LATHES
How "A Smoother Rolling Action" Can Be Designed Into Machine Tools
Because Farrel-Sykes herringbone gears – the famous *Gear with a Backbone*–have continuous teeth without a center groove, the entire face width is put to work, providing a greater area of tooth contact. This results in greater strength and smoother rolling action.
This is one of the principal reasons why so many manufacturers specify the *Gear with a Backbone* for their lathes, drills, boring mills and other machine tools. In addition, they find that the accurate tooth contour of these gears, coupled with correct tooth action, gradual engagement and oblique lines of contact, keeps wear to an absolute minimum.
Farrel-Sykes gears are available to you, too, in any size up to 20 feet in diameter, for practically any application. Information and engineering assistance are yours, without obligation.
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FOR HEAVY DUTY MACHINE APPLICATIONS
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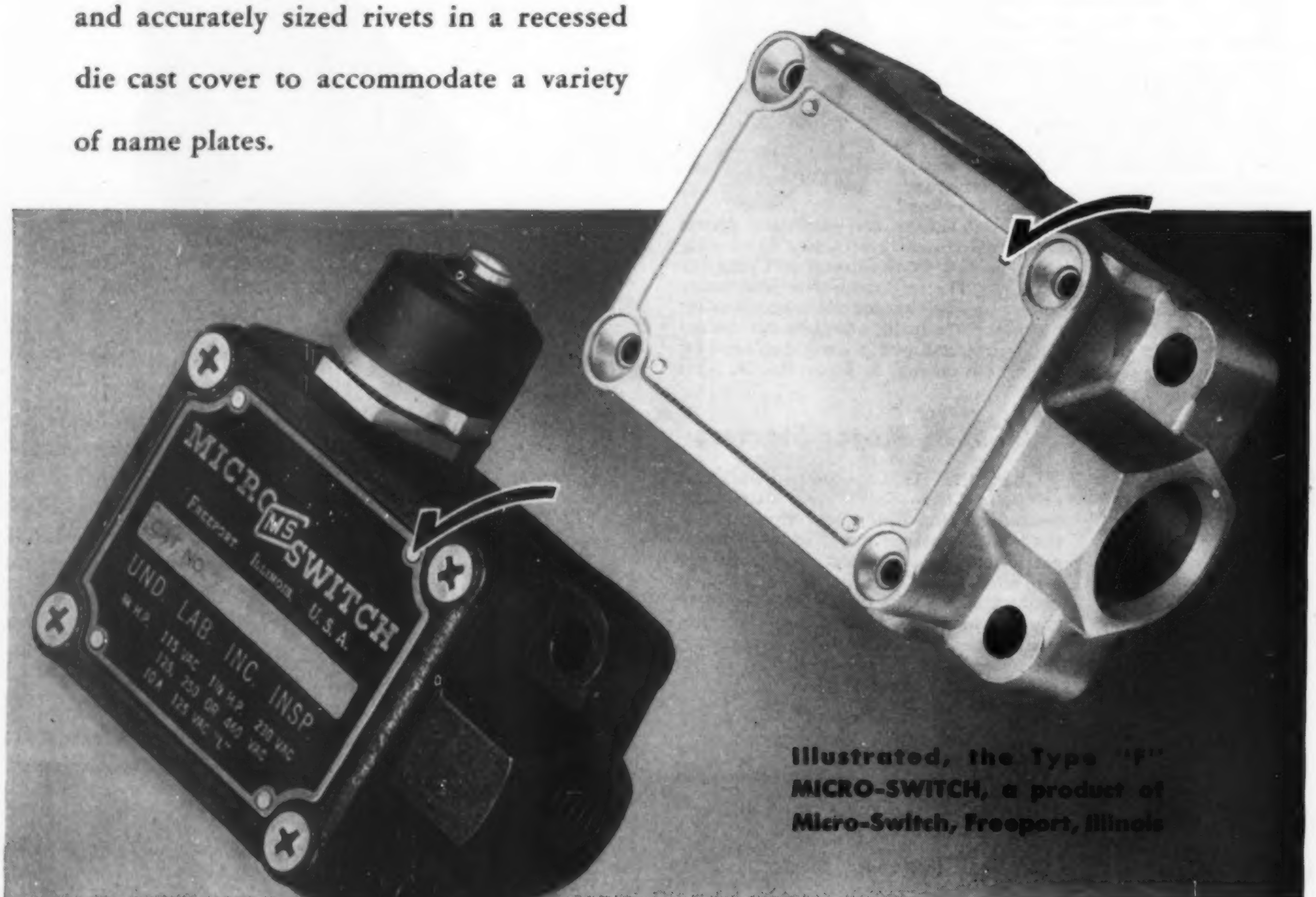
DESIGN IDEAS THAT PAY

in MADISON-KIPP *aluminum die castings*

MICRO SWITCH designers, committed by tradition to highest quality material, required a sturdy interchangeable name plates design.

Madison Kipp casts four accurately spaced and accurately sized rivets in a recessed die cast cover to accommodate a variety of name plates.

Engineers and designers often find helpful cooperation by Madison Kipp craftsmen whose life work has been the practical application of die castings to new uses.



Illustrated, the Type "F" MICRO-SWITCH, a product of Micro-Switch, Freeport, Illinois

MADISON-KIPP CORPORATION

210 Waubesa Street, Madison 10, Wis., U.S.A.

ANCIENS ATELIERS GASQUY, 31 Rue du Marias, Brussels, Belgium, sole agents for Belgium, Holland, France, and Switzerland.

WM. COULTHARD & CO. Ltd., Carlisle, England, sole agents for England, most European countries, India, Australia, and New Zealand

- *Skilled in* DIE CASTING *Mechanics*
- *Experienced in* LUBRICATION *Engineering*
- *Originators of Really High Speed* AIR TOOLS

K+E

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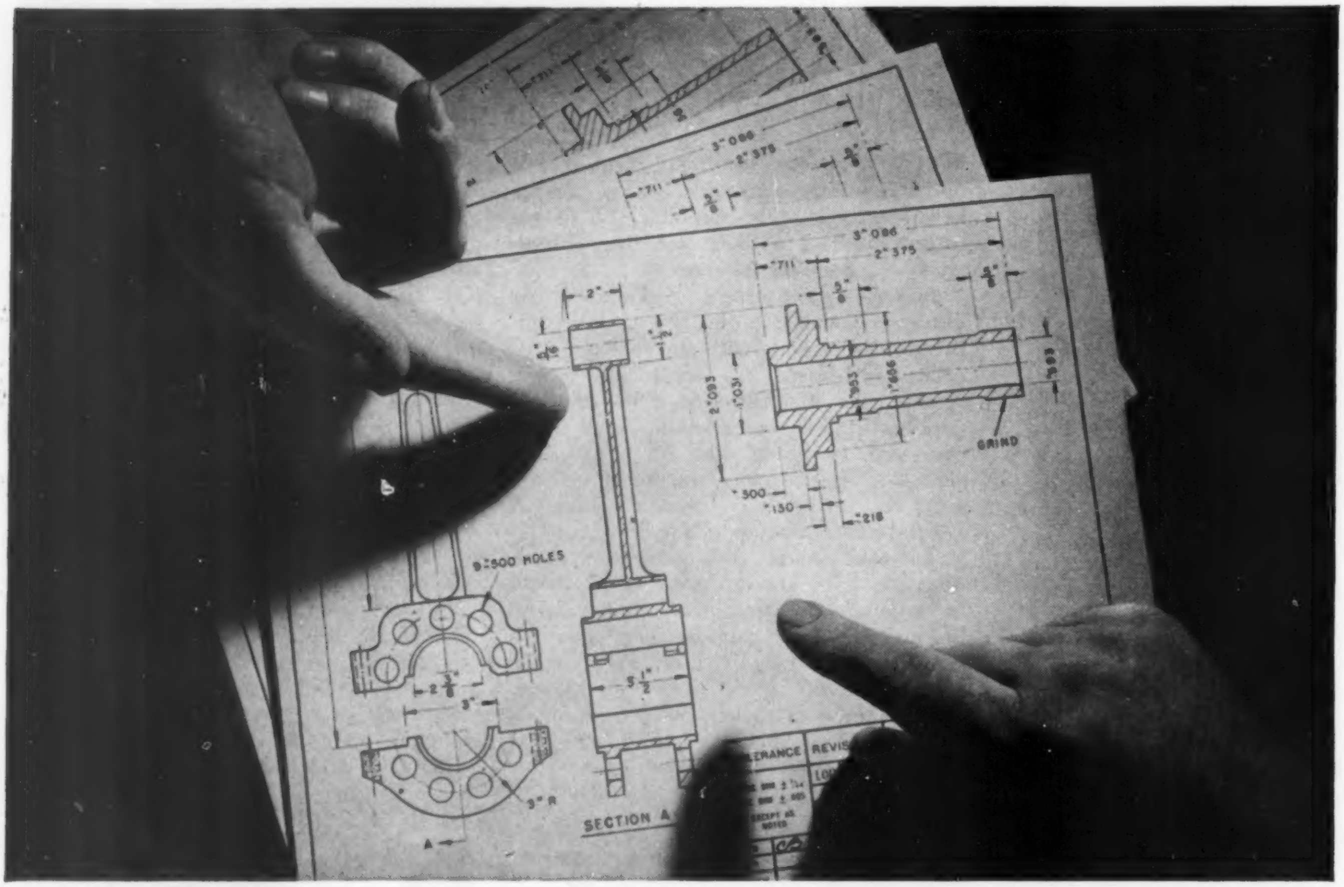
For 81 years K & E equipment and materials have been



POSITIVE LINE PRINTS THAT ARE CONSISTENT

When you make positive line, dry developed prints, you need consistent results from dependable materials. That is our constant goal in the manufacture of the HELIOS* line of papers, cloths and films.

To be sure of absolute K&E standards in the color-forming components required for these dry diazo products, we established a new plant where we manufacture HELIOS materials exclusively. We not only control and make the finished materials, but actually manufacture, from the raw materials, the image-forming chemical components as well. Thus HELIOS papers, cloths and films are the direct product of 81 years of K&E experience and K&E insistence on quality first.

HELIOS dry developed materials cover a wide field of reproduction needs. They consist of opaque papers (black, blue and maroon line) and opaque cloth for working prints, besides transparent papers and cloth and clear and matte films, for intermediate originals (to use instead of originals).

in creating...

partners of the engineer, the scientist and the draftsman in shaping the modern world.

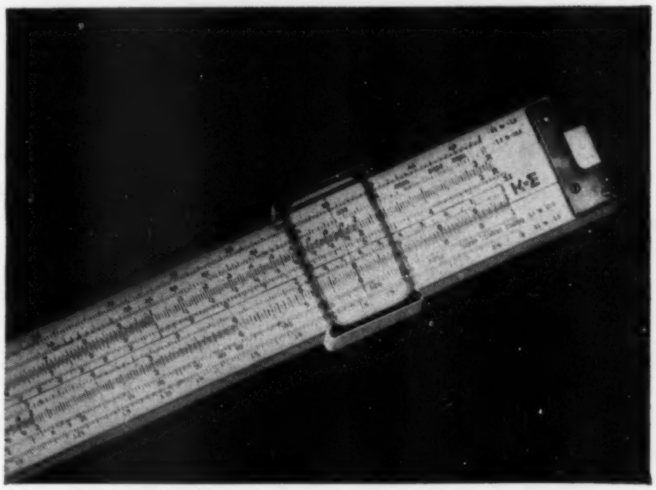
For samples and full information about the HELIOS line and what it can do for you, ask any K&E Branch or Dealer or write us here in Hoboken, N. J.

NEW TYPE RULING PENS

MARATHON† Ruling Pens hold several times more ink than ordinary ruling pens. They save refilling time, because they draw five to eight times more line between fillings. They are made in three fixed widths to rule three different widths of line. The ink-flow is regular and lines are always sharp, clean and uniform in width.

MARATHON Pens are easy to handle for guided curve lines or freehand contour line work. They can be laid down flat even when filled, without the ink running out. Easily filled, cleaned and sharpened. Sold in sets of three or singly.

Ask your K&E Dealer or K&E Branch to show them to you.



YOUR SLIDE RULE

To the engineer, scientist, mathematician and student, Slide Rules and K&E are synonymous. The new N4080 and N4081 LOG LOG DUPLEX TRIG and DECITRIG* rules, for instance, are typical of the thoroughly seasoned materials, the precision and detail of workmanship for which K&E Slide Rules have long been recognized as the standard of quality. When you need a Slide Rule, insist on K&E.

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*Trade Mark®
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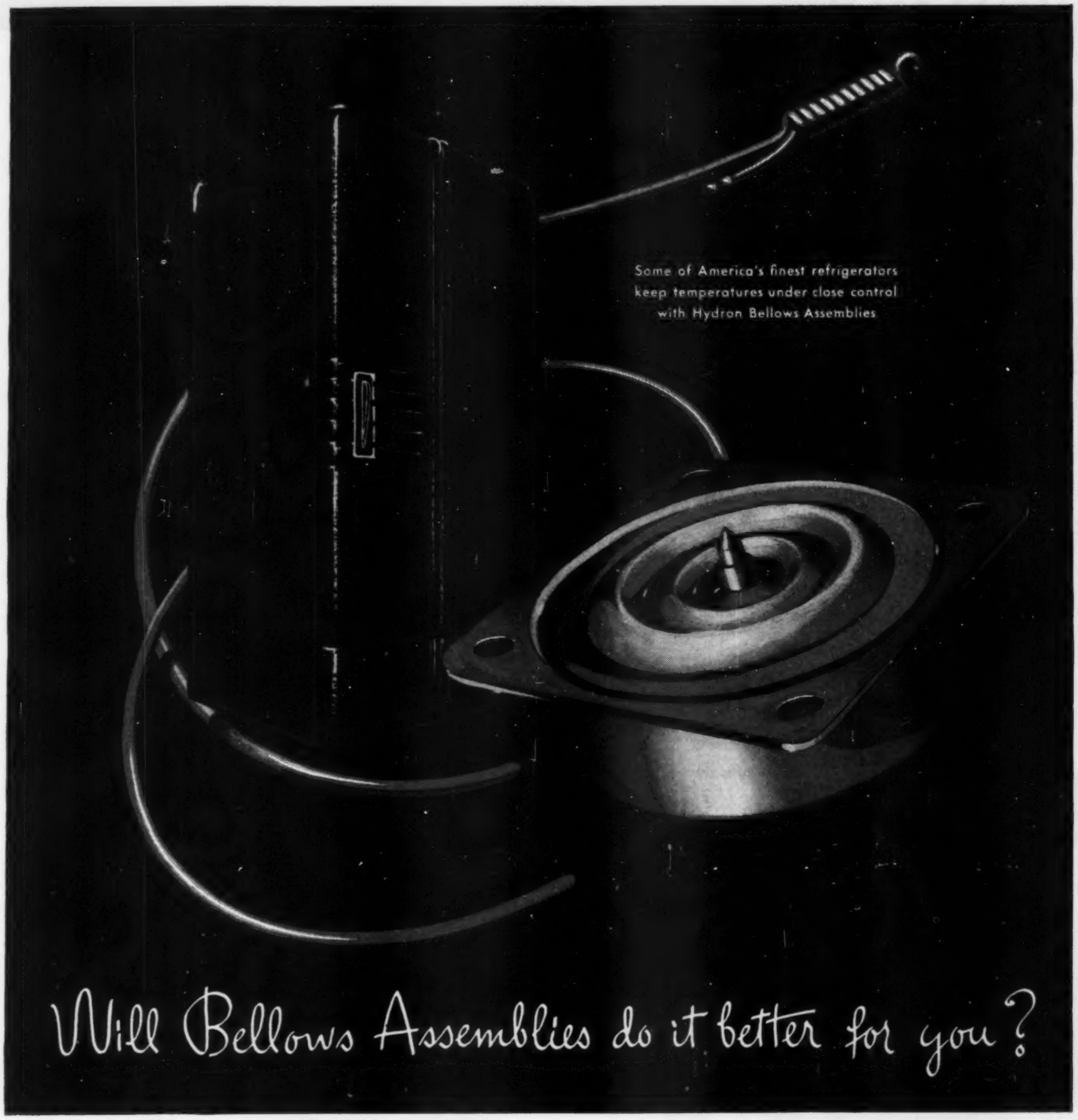


Many other firms looking for better ways to control temperature or pressure, to seal shafts or valves against leakage, or to transmit motion, have turned to bellows assemblies. Investigation before your designs are too far advanced may pay you, too. Let our engineering department make a confidential analysis of your sketches and specifications and make a recommendation. No obligation, of course.

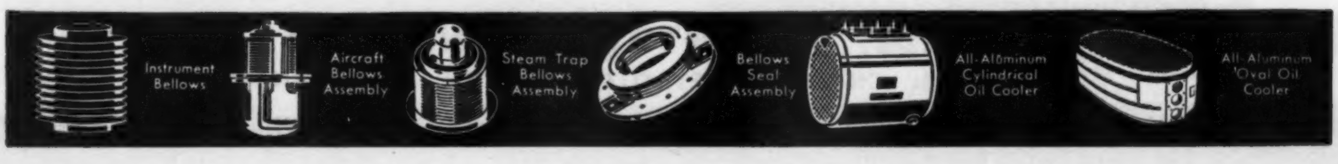
CLIFFORD MANUFACTURING COMPANY, 566 GROVE ST., WALTHAM 54, MASS. *Division of Standard-Thomson Corporation.* Offices in New York, Detroit, Chicago, Los Angeles.

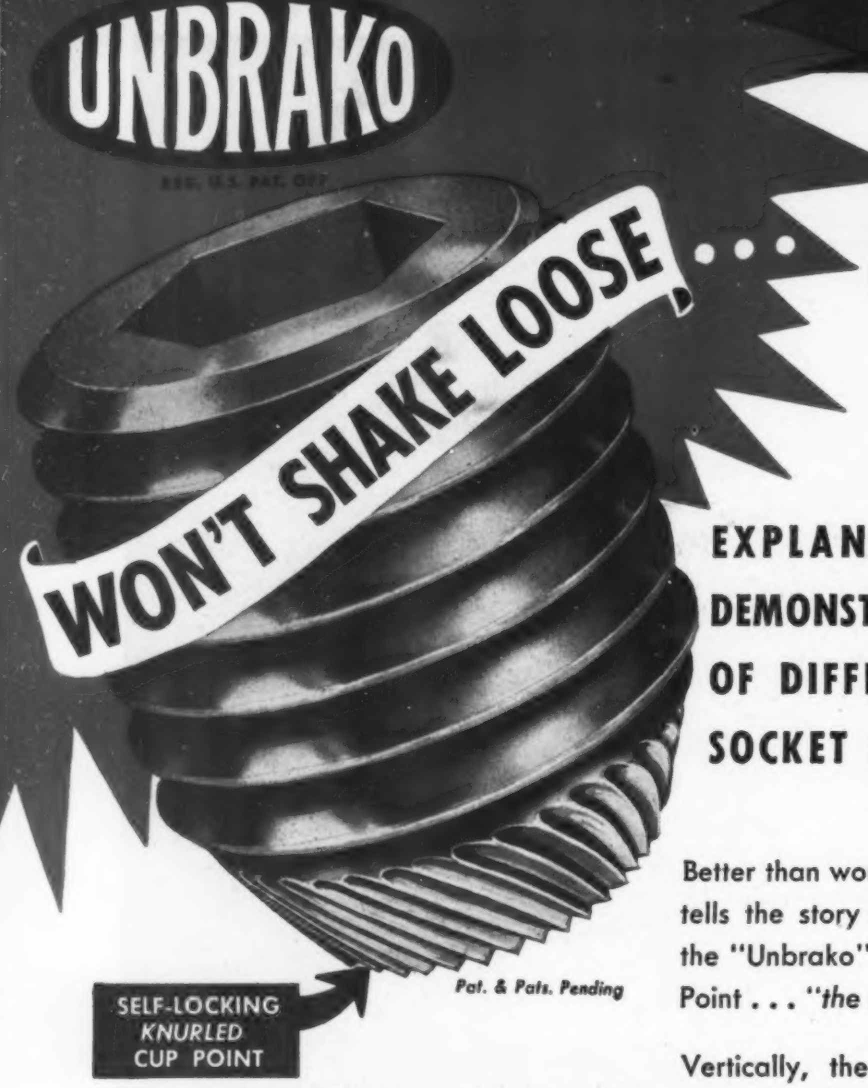
HYDRON Metal Bellows

CLIFFORD

HYDRAULICALLY - FORMED BELLOWS AND BELLOWS ASSEMBLIES

ALL-ALUMINUM OIL COOLERS FOR AIRCRAFT ENGINES





... proved by

EXPLANATION OF VIBRATION TESTS DEMONSTRATING THE HOLDING POWERS OF DIFFERENT TYPES OF "UNBRAKO" SOCKET SET SCREWS

Better than words, the graph of actual vibration tests quickly tells the story of the exceptional "HOLDING POWER" of the "Unbrako" Self-Locking Set Screw with the Knurled Cup Point . . . *"the screw that won't shake loose."*

Vertically, the graph is divided into increments of 30 minutes. Each bar—black for Plain Cup Point and red for Knurled Cup Point—represents a screw tested and the number of minutes at which it loosened. *The height of each black bar, therefore, is a direct measure of the length of time before the plain pointed screw shook loose.* The Self-Locking Knurled Cup Pointed Screws—indicated by the red bars—were still tight at 300 minutes.

All screws were tested under identical conditions. Rate of vibration—1750 cycles per minute . . . duration of test—until screw shook loose or tests were discontinued.

Analyzing the graph and comparing the two types of screws, we find that the most favorable test of the Plain Cup Point shows a failure at 10 minutes and 40 seconds. *No Knurled Cup Point shows signs of loosening at 300 minutes—more than 28 times the "HOLDING POWER" of the Plain Cup Point—a tremendous superiority . . . as proven by actual tests and use.*

The "Unbrako" Self-Locking Set Screws with the Knurled Cup Point can be used over and over again.

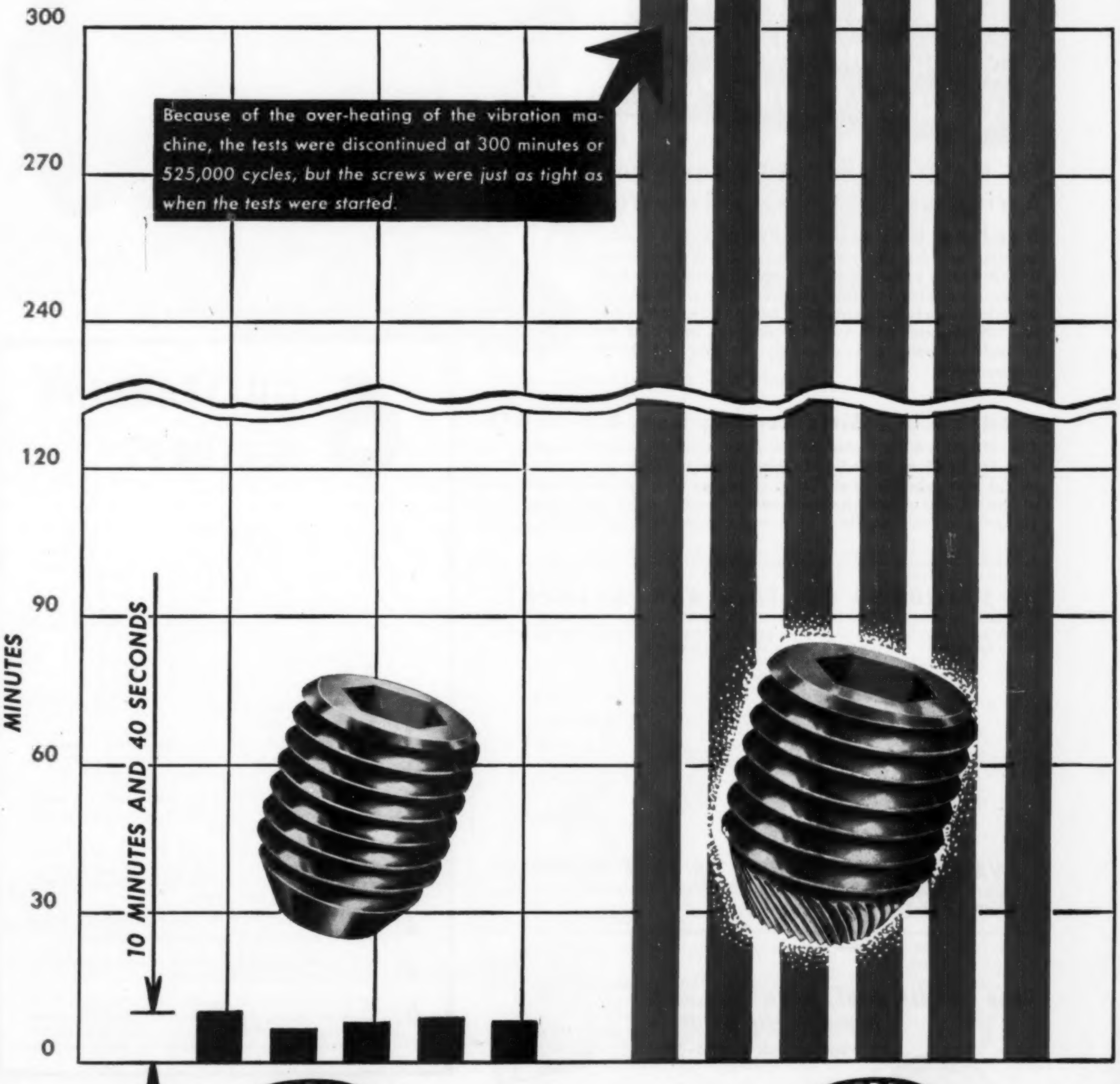
OVER 45 YEARS IN BUSINESS

STANDARD PRESSED STEEL CO.

BOX 102, JENKINTOWN, PENNSYLVANIA

BRANCHES: CHICAGO DETROIT ST. LOUIS SAN FRANCISCO

actual tests

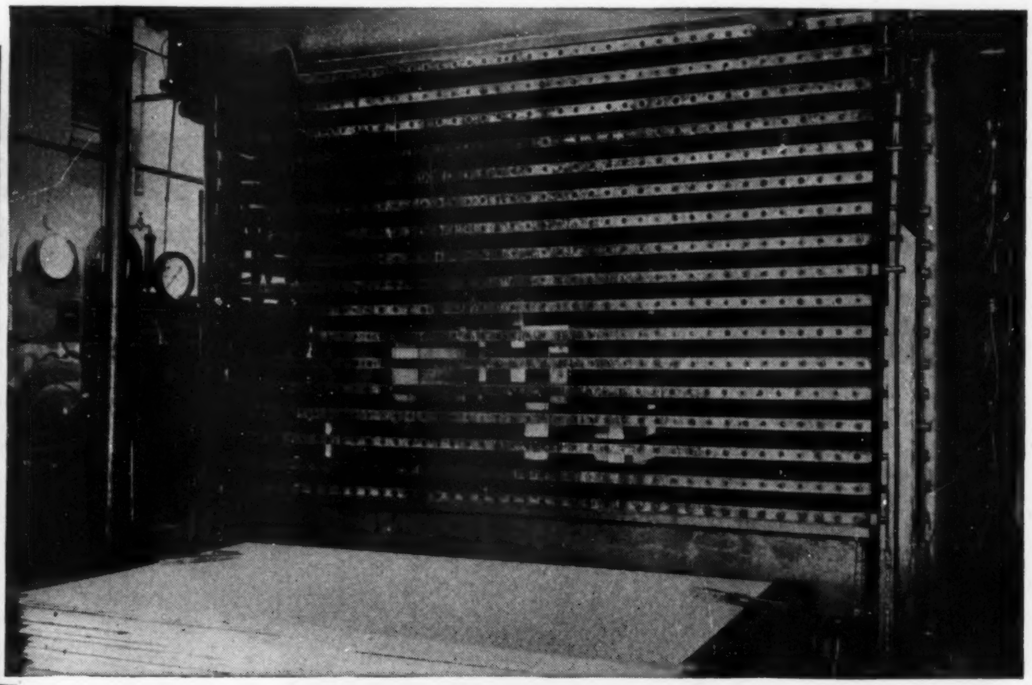


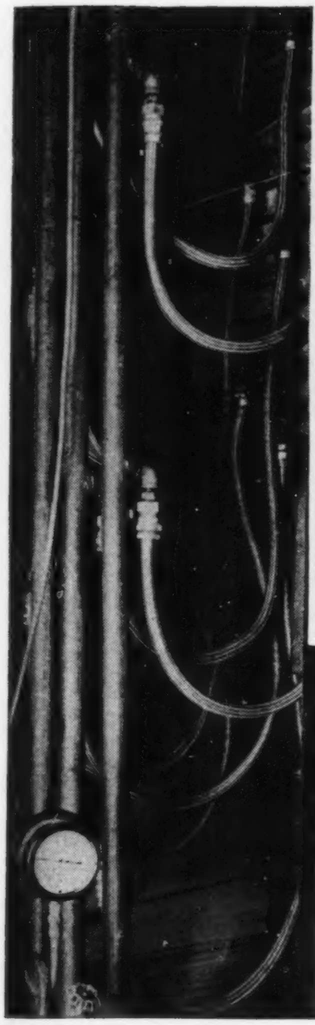
UNBRAKO
PLAIN CUP POINTS

UNBRAKO
KNURLED CUP POINTS
Pat'd & Pat's Pending

Life-Line

NOW... LUBRICATED for LIFE

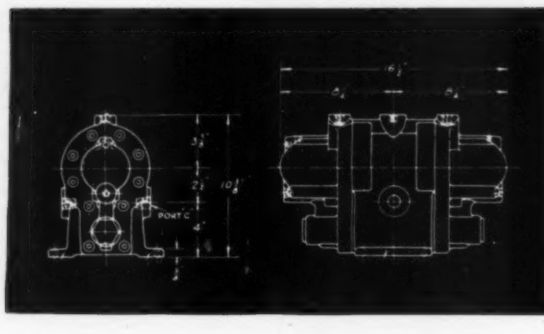




Above: 16-opening press for bonding plywood—at a large West Coast plywood plant. Note panels in foreground.
At Left: Close-up showing some of the American Seamless S-1 Flexible Bronze Tubing Steam Connectors to the 17 platens of the press.

A RACINE

Oil Hydraulic Pressure Booster



--WILL INCREASE OIL PRESSURES AS MUCH AS 7 to 1

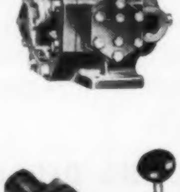
The Racine Hydraulic Pressure Booster is a simple, compact, self-contained pumping unit. It is adaptable to existing or new circuits, using either constant or variable volume pumps. Its use provides high and low pressure for your hydraulic circuit. Horsepower requirements remain constant because as pressure increases, volume decreases.

RACINE HYDRAULIC BOOSTERS reduce initial investment because they eliminate the need of high pressure pumping and extra capacity power units. Compact leak-proof construction. No gears to wear out, no external working parts, no special mounting or foundation required. Standard units are available in various ratios to produce pressures as high as 5000 lbs. p.s.i. Write for complete descriptive circular. Address RACINE TOOL & MACHINE CO., 1773 State St., Racine, Wisconsin.

RACINE

Standard for Quality and Precision

RACINE *Oil Hydraulic* PUMPS AND VALVES



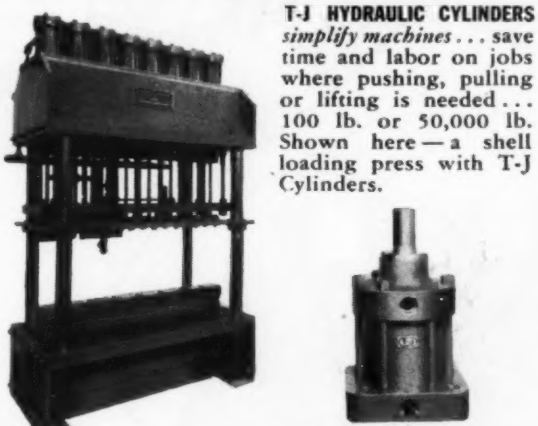
Investigate RACINE'S Variable Volume Hydraulic Pump line. Ideal for use in automatic precision type machine control where low and high pressures are required for either slow or fast operations. 50 to 1000 lbs. oil pressure p.s.i. at 0 to 30 g.p.m.

Racine's Oil Hydraulic Valve line is available in a wide range of styles with either manual, electrical or mechanical controls. Sizes 3/8" to 1 1/2" I.P.S. Ask for complete RACINE HYDRAULIC PUMP CATALOG No. P-10-C.

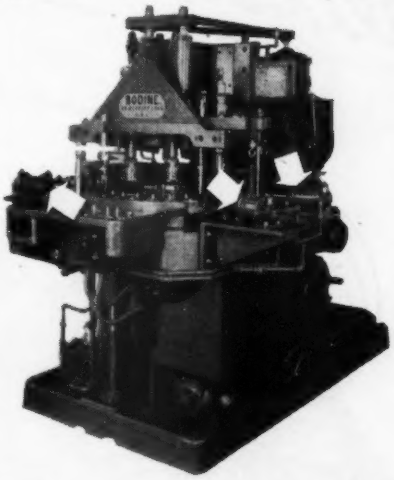
HERE'S HOW

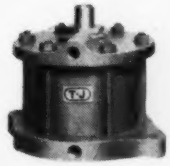
T-J SAVES LABOR

ON THOUSANDS OF JOBS FOR INDUSTRY!

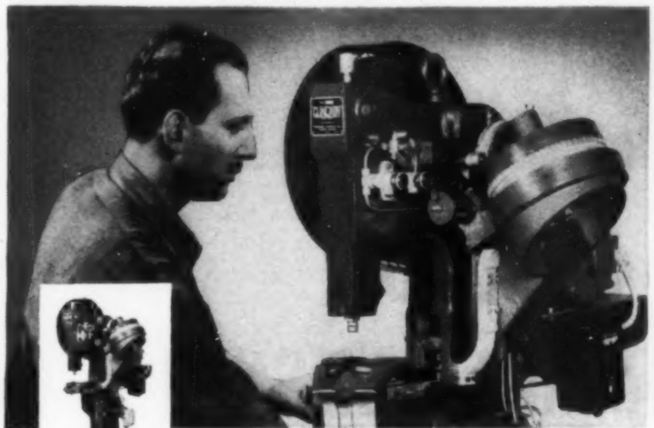


T-J HYDRAULIC CYLINDERS *simplify machines* . . . save time and labor on jobs where pushing, pulling or lifting is needed . . . 100 lb. or 50,000 lb. Shown here — a shell loading press with T-J Cylinders.

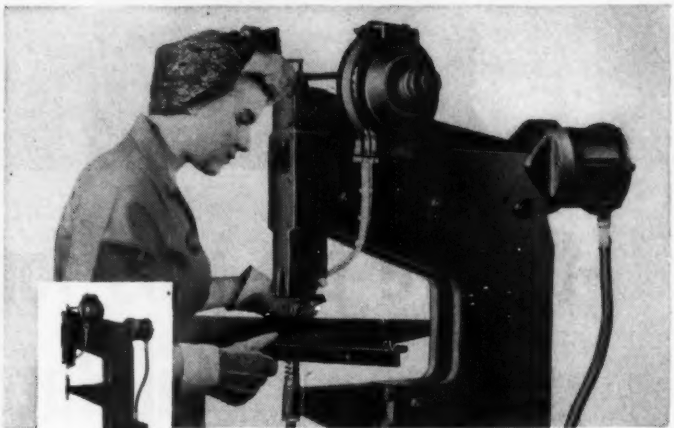




T-J AIR CYLINDERS *do push-pull-lift jobs* . . . 100 lb. to 12,000 lb. . . . wide range of styles, sizes and strokes. Shown here — Automatic Drilling and Threading Machine with T-J Cylinders.

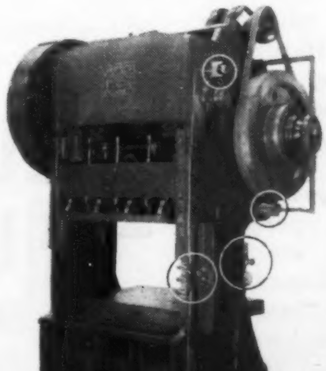


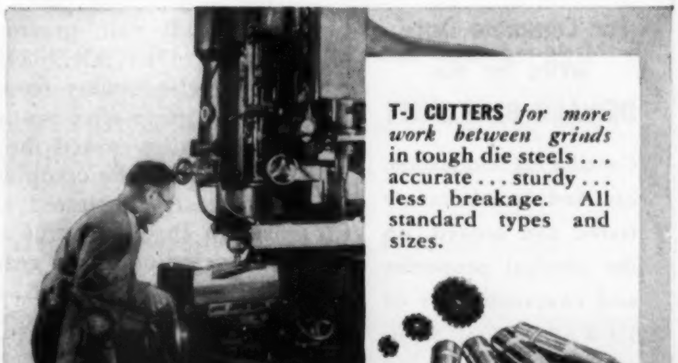
T-J CLINCHORS *set clinch nuts 3 to 5 times faster* in automotive body panels, door locks, other products. Fully automatic—controlled by foot pedal.



T-J RIVITORS *with automatic feeding and setting . . . air powered* for aluminum alloy rivets 1/16" to 1/4" dia., up to 3/4" long. *Electrically powered* for solid steel rivets 1/16" to 1/4" dia., up to 7/8" long.

T-J AIR CONTROLS *provide accurate, automatic control* for presses, brakes, other machines and equipment . . . designed for air cylinders in semi-automatic or automatic cycles.





T-J CUTTERS *for more work between grinds* in tough die steels . . . accurate . . . sturdy . . . less breakage. All standard types and sizes.

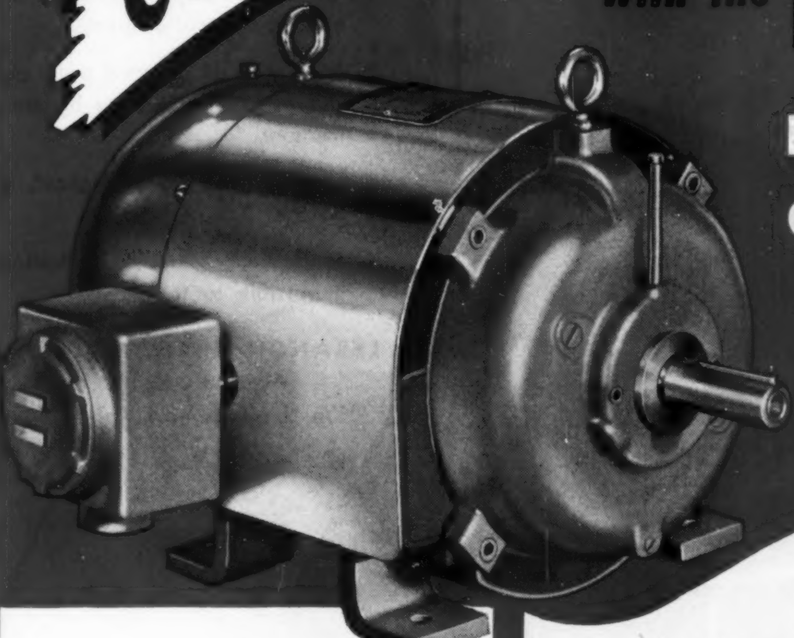
Send for catalogs.
The Tomkins-Johnson Co.
Jackson, Michigan

T-J
TOMKINS-JOHNSON
RIVITORS . AIR AND HYDRAULIC CYLINDERS . CUTTERS . CLINCHORS

32 YEARS EXPERIENCE

COMPLETE INSURANCE

with the RELIANCE EXPLOSION-PROOF and CORROSION-RESISTING MOTOR



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Here is the result of Reliance engineering applied to the problem of protecting motors that operate in either corrosive or explosive atmospheres. Frame and fan covers, fan, conduit box and end brackets are all made of selected corrosion-resisting materials. In addition, many extra steps are taken to achieve maximum protection, such as coating screws, counterboring screw holes and fitting-up with special compounds.

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In the new Type "A" Switch, MICRO SWITCH offers a small, lightweight, accurate switch to handle the high current inrush required in the operation of solenoids, motors and tungsten lamps.

The MICRO Type "A" Switch is listed by Underwriters' Laboratories for 1½ H.P. motor, 230 volts a-c; ¾ H.P. motor, 115 volts a-c; 20 amperes, 125, 250 or 460 volts a-c; tungsten lamp, 10 amperes, 125 volts a-c. Rated for 75 amperes inrush capacity to 460 volts a-c.

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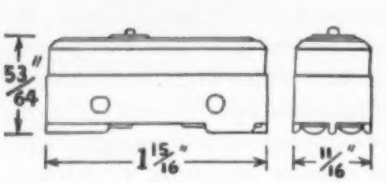
New MICRO Type "A" Switch



This small switch will handle a 1½ H.P. motor at 230 volts a-c. It is available with five different types of actuators.

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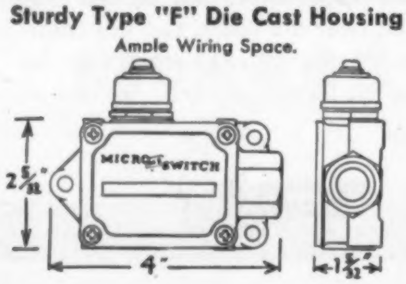

This MICRO Type "F" die cast housing is designed for the high capacity Type "A" Switch. The synthetic rubber seal boot covers the operating plunger and resists the entrance of oil, moisture, dust, etc. Available in right and left hand designs.

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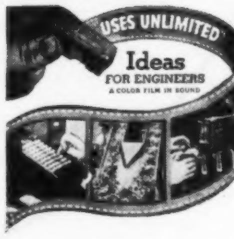

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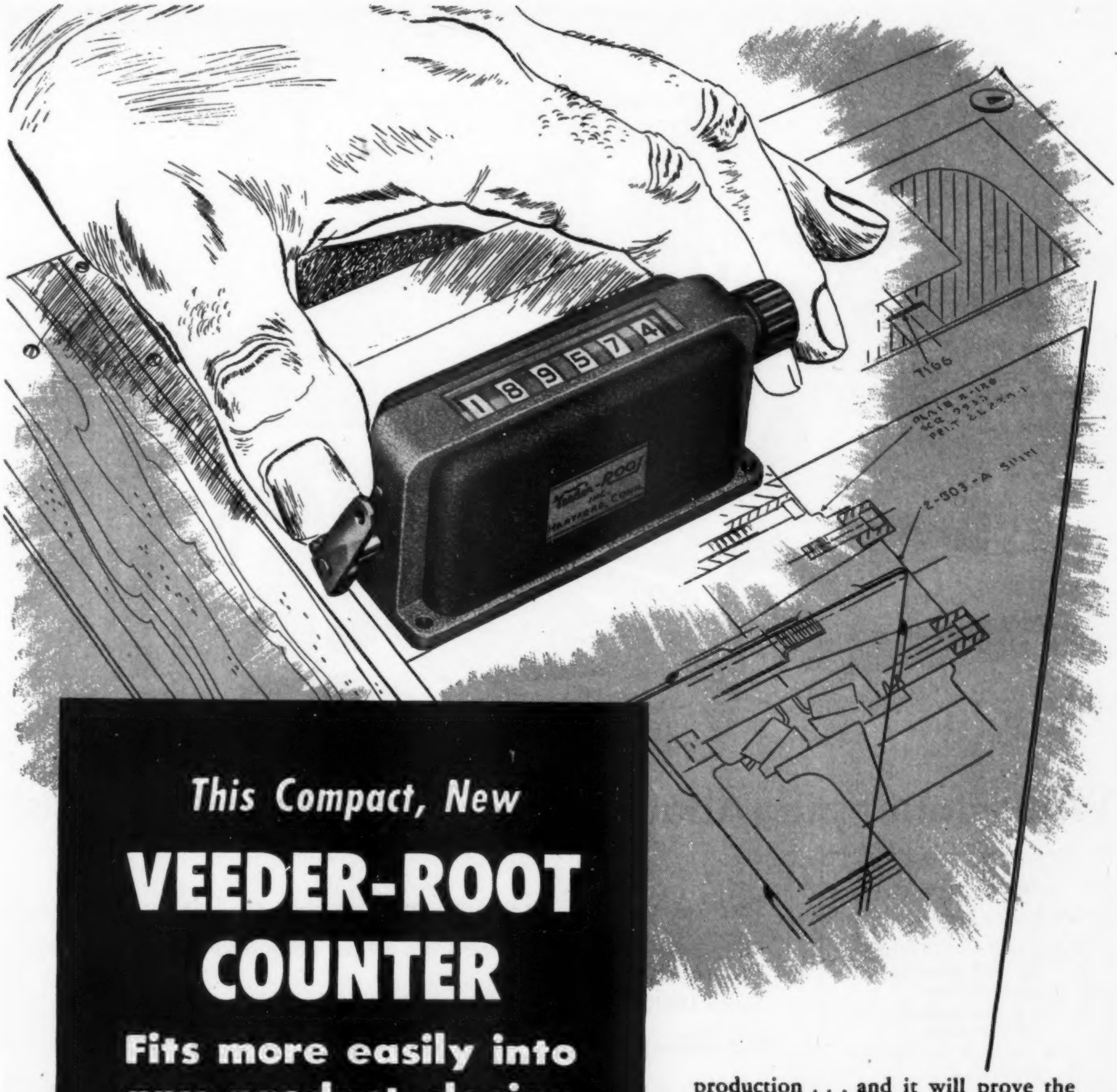

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Fits more easily into <u>any</u> product-design

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And the new 1260 will fit into the closest design-limitations. For it measures only 4½" long, 1 9/16" high, 1½" wide . . . weighs only 12 ounces. Speeds from 1,000 to 5,000 counts per minute, depending on type of drive: ratchet, revolution, direct, or geared. Capacity is 1,000,000 counts. Then one turn of the knob resets to all zeros.

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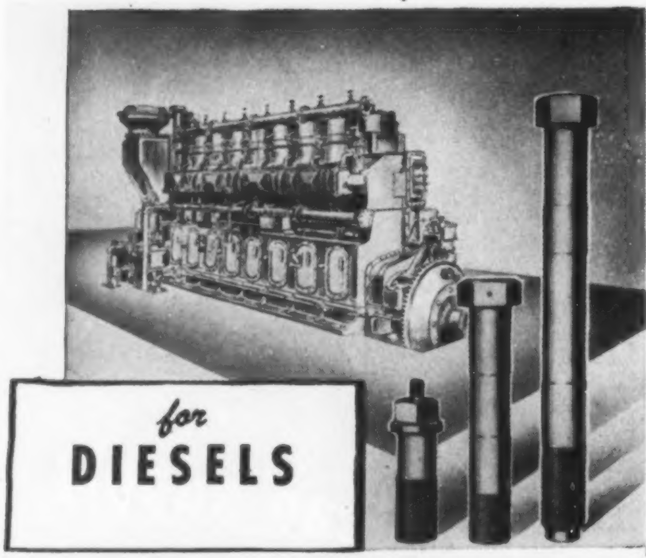

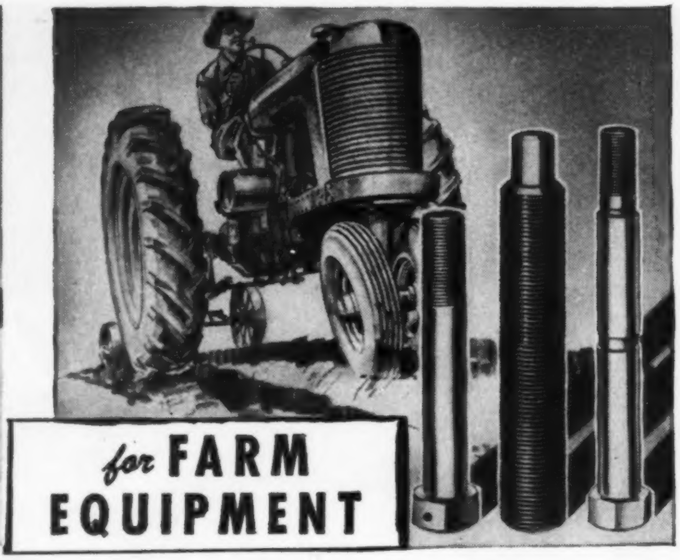

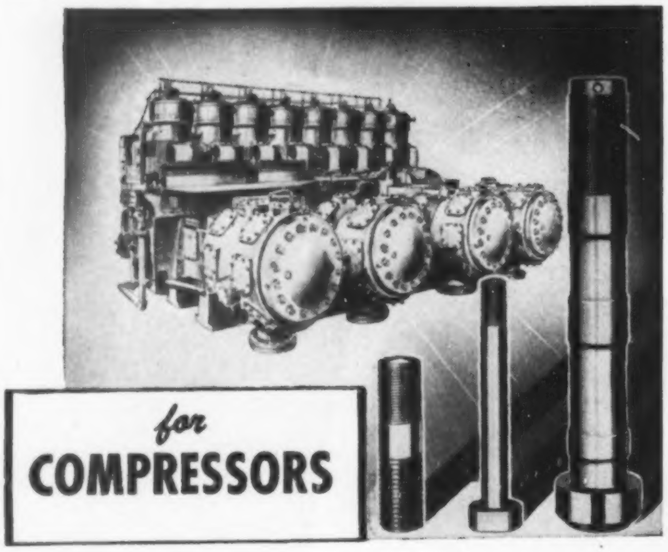

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Topics

SINGLE-CRYSTAL sheets of metal are now being produced to better study the compositions of the crystals themselves. In the method, developed by Westinghouse, a metal sample is heated just above its melting point in the best possible vacuum and then cooled very slowly and evenly, forming a sheet ½-inch long, ½-inch wide and a single crystal thick.

SILVER-VAPOR coating on plastic windows for aircraft was used in Germany to reduce glare of searchlights in night flying. Process adapted to other metals was considered for use as a hard protective coating or as an electrically conductive layer for defrosting.

CERAMIC radio tubes have advantages over glass or metal-envelope types for microwave systems. Tubes must be small, requiring operation at high temperature which involves problems with both glass and metal. Ceramic tube is bonded to metal base by an alloy of silver and titanium. Resulting joint is stronger than the ceramic itself.

MOISTURE in sheet materials may be measured continuously during processing with a new electronic instrument. Material is passed between two metal plates. Electric current passing between them depends upon the moisture present, reading on instrument dial being in percentage of moisture.

NEW TECHNIQUE in the manufacture of face plates for television tubes has been developed by Pittsburgh Plate Glass. The meticulous grinding and polishing operations are reduced to a standardized process which is completed while the glass is still flat. Bending process has been developed to produce perfect sphericity without marring the precision surface before the blanks are cut to size.

ELECTRONIC DEVICE, capable of translating mechanical vibration into audible or visual signals, has been developed by R.C.A. Measuring instrument is an electron tube, about one inch in length and $^1/_{16}$-ounce in weight, and is capable of measuring vibrations caused by a fly walking on a steel beam. Detection of defects in airplane construction or dynamic unbalance in rotating machinery as well as vibration measurements on movable mechanical parts are major applications for this instrument which is not affected by changes in humidity.

FOUR SHADES of gray for use in painting industrial machinery and equipment are recommended in a proposed standard of the American Standards Assn. Use of these shades will help in matching and in providing better color harmony. Specified by number and Munsell notation the standard shades are light gray, medium light gray (or standard machine tool gray 7-B), medium dark gray, and dark gray. Color chips for visual comparison are available.

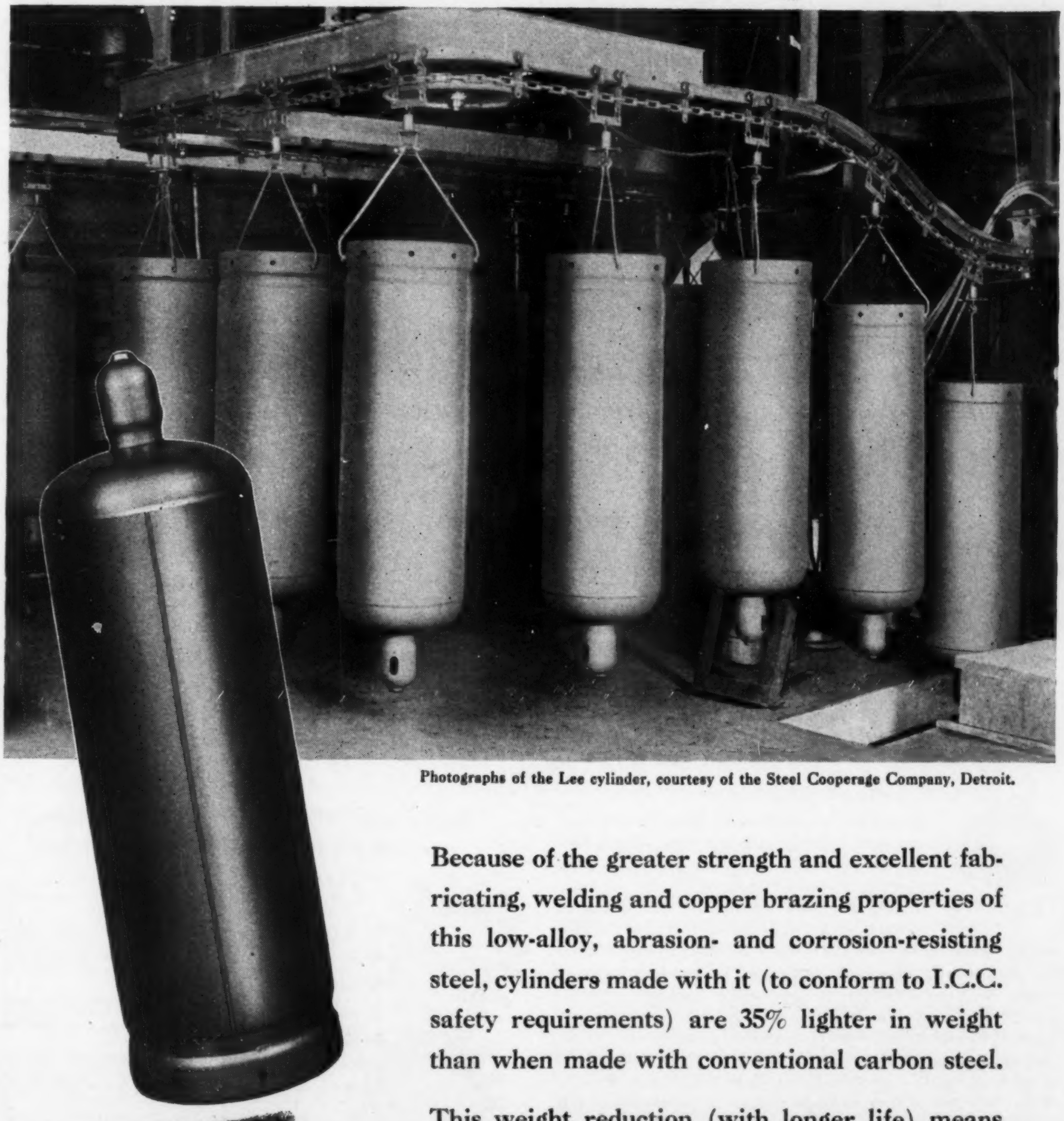
THICKNESS of composite copper-nickel coatings electrodeposited on steel may be determined by a nondestructive magnetic method developed at the National Bureau of Standards. Method involves measuring the attractive force between the plated specimen and two permanent magnets of different strengths. The values thus obtained determine the total thickness of the coatings as well as the relative thicknesses of the copper and nickel layers.

BONDING FILM, a thermosetting adhesive in the form of scotch tape, is used for the joining all kinds of materials—metals, woods, fiber, cloth—in any combination. Developed by Minnesota Mining & Manufacturing Co., this Scotch-Weld develops adhesive strength of 3500 psi for aluminum to aluminum, 2800 psi for metal to plastic and no failure of bond for cloth to cloth or metal to wood. Curing time averages from few minutes to one hour at about 70 psi pressure and 300 to 400 F.

LARGEST aluminum casting produced in a plaster mold was made in the foundry of Morris Bean & Co. for Goodyear Tire & Rubber Co. The casting is 95 inches in diameter and was made in a gypsum composition mold weighing 5600 pounds.

N-A-X HIGH-TENSILE STEEL in L.P.G. Cylinders

means light weight with added safety and durability



Photographs of the Lee cylinder, courtesy of the Steel Cooperage Company, Detroit.

Because of the greater strength and excellent fabricating, welding and copper brazing properties of this low-alloy, abrasion- and corrosion-resisting steel, cylinders made with it (to conform to I.C.C. safety requirements) are 35% lighter in weight than when made with conventional carbon steel.

This weight reduction (with longer life) means greatly reduced shipping and handling costs . . . and over-all savings to consumers.

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HIGH-TENSILE STEEL

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This **BULLETIN** *will answer Your* **MECHANICAL SEAL QUESTIONS**

DESIGN FEATURES

A. Tail of synthetic rubber bellows is preloaded on the shaft. Gives a positive, non-slipping drive.

B. Bellows head is flexible; adjusts automatically for washer wear and shaft end play.

C. Protecting ferrule prevents flexible bellows from adhering to shaft; assures free movement.

D. Sealing washer rotates with shaft; driven through metal parts—no torque on bellows.

E. Sealing faces both carefully lapped at our factory to insure a perfect seal.

F. Floating seat is cushioned in synthetic rubber sealing ring, eliminating stress distortion of sealing faces.

The JOHN CRANE Bellows Shaft Seal is being used with great success on centrifugal pumps, speed reducers, refrigeration compressors; all types of sealing applications. It is fully illustrated by the bulletin shown above.

The advantages this precision-built Shaft Seal has over packings are many. It reduces friction and saves power. Requires minimum attention over long periods of operation. *Completely eliminates* gland adjustment, stuffing box leakage and shaft wear.

With a JOHN CRANE Shaft Seal in your equipment, these advantages become important additional features to stress in competitive markets. Every manufacturer or Design Engineer who has a shaft sealing problem should see this bulletin. *It's informative—write for a copy!*

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MACHINE DESIGN

Bouncing Basket Washer

... employs unique wash and balancing principle; simple, economical shifting mechanism

By Richard K. Lotz
Associate Editor, Machine Design

Fig. 1—"Bouncing basket" washer operates on unique washing principle and also incorporates novel balancing device

CULMINATING an intensive engineering program, a new automatic clothes washer, *Fig.* 1, was recently placed on the market by Apex Electrical Manufacturing Co. of Cleveland. This washer, named the Wash-a-Matic, operates on a brand new washing principle in which the soapy water is propelled in spouts or geysers up through the clothes by virtue of the "bounc-

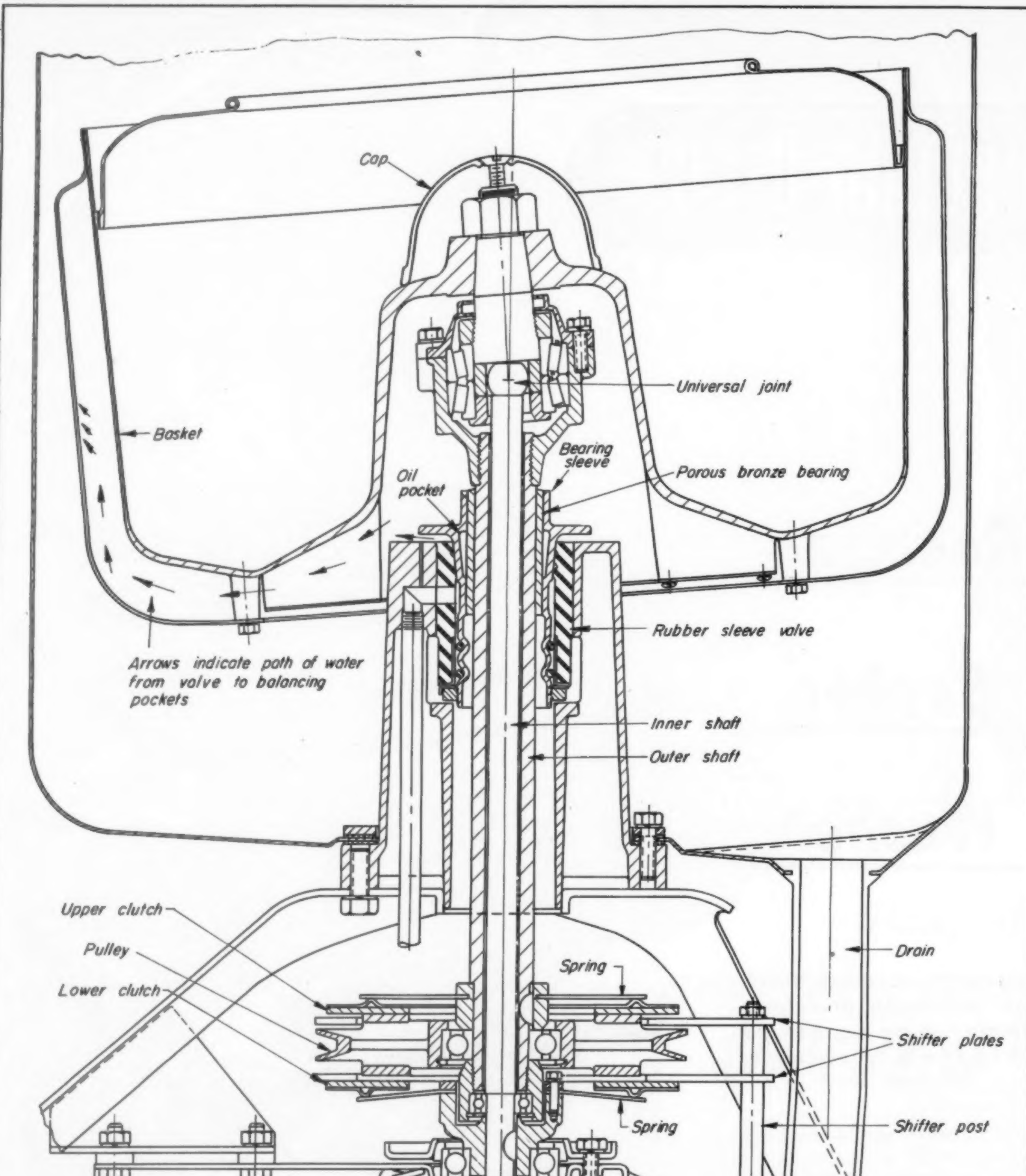

Cap
Universal joint
Basket
Bearing sleeve
Oil pocket
Porous bronze bearing
Rubber sleeve valve
Arrows indicate path of water from valve to balancing pockets
Inner shaft
Outer shaft
Upper clutch
Pulley
Lower clutch
Spring
Drain
Shifter plates
Spring
Shifter post
Diaphragm unit

Fig. 2 — Left — Cross section through new washer illustrates simplicity of diaphragm actuated shifting mechanism and the novel balancing method in which a rubber sleeve valve directs water into pockets evenly spaced around the basket periphery

ing" action imparted to its basket.

The mechanism which produces this unique rapid wobble or bouncing action is simple in design and sturdy in construction. As will be seen in *Fig.* 2, the basket is mounted on a short shaft running in tapered roller bearings and is tilted. This shaft is directly driven by a solid shaft through a universal joint. Outer races of the bearings are supported in a member which is fastened to the top of a tubular outer shaft. When the inner shaft is held stationary while the outer shaft spins, the basket wobbles. When the outer shaft is held stationary while the inner shaft spins, the tilted basket spins without wobbling. This latter action occurs during the spin-dry cycle of the machine.

Balancing Posed Problem

Perhaps the most intriguing problem in functional design encountered during development of the washer was that posed by off-balance during spin-drying. More often than not clothes are unequally distributed in the washer basket and at high-speed spin, the out-of-balance, unless compensated, causes the entire machine to vibrate.

Like the washing principle, the balancing method is also new and unique. Eight pockets are welded around

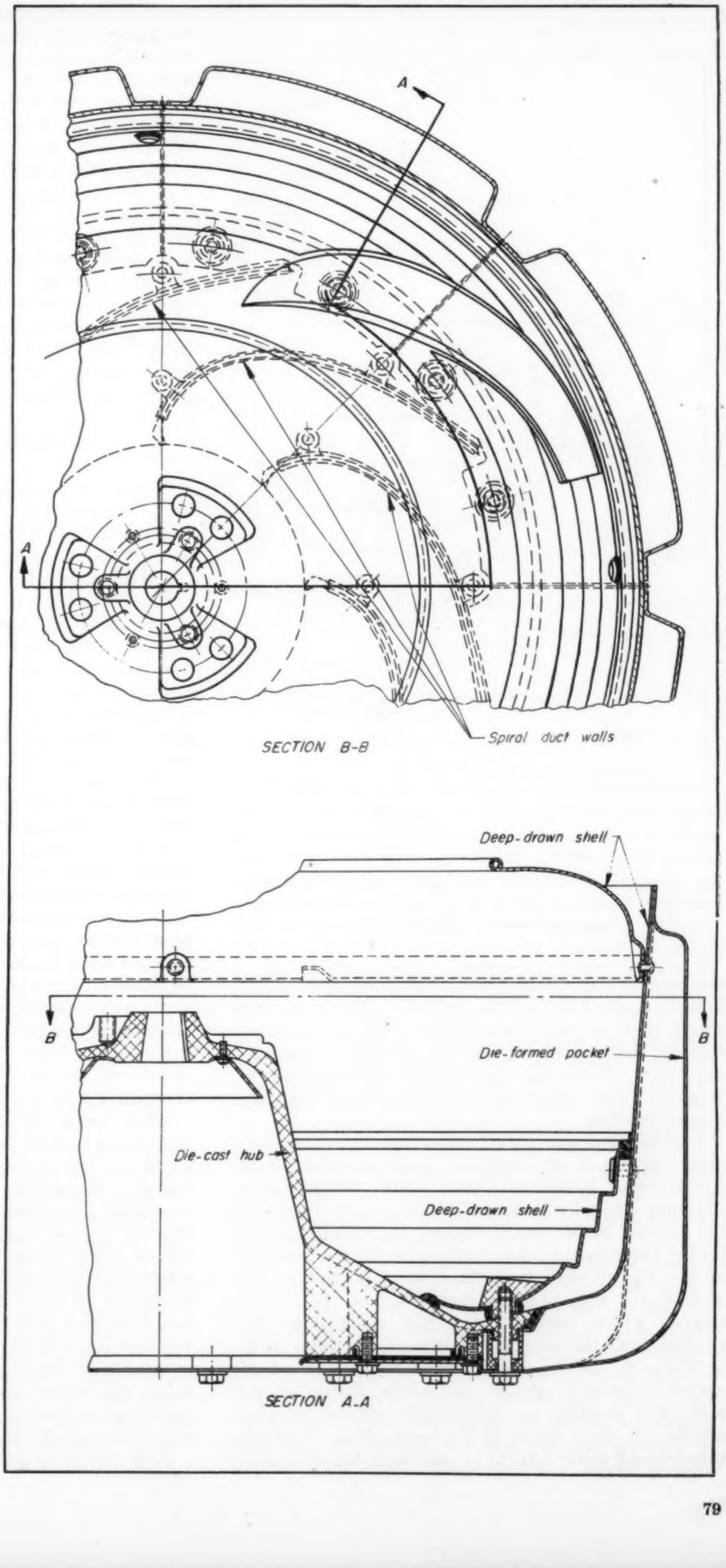


Fig. 3 — Right — Construction of basket as mass produced. Hub is die-cast aluminum and shell members are deep-drawn aluminum. Top view shows shape of the spiral-shaped ducts which are cast into the hub

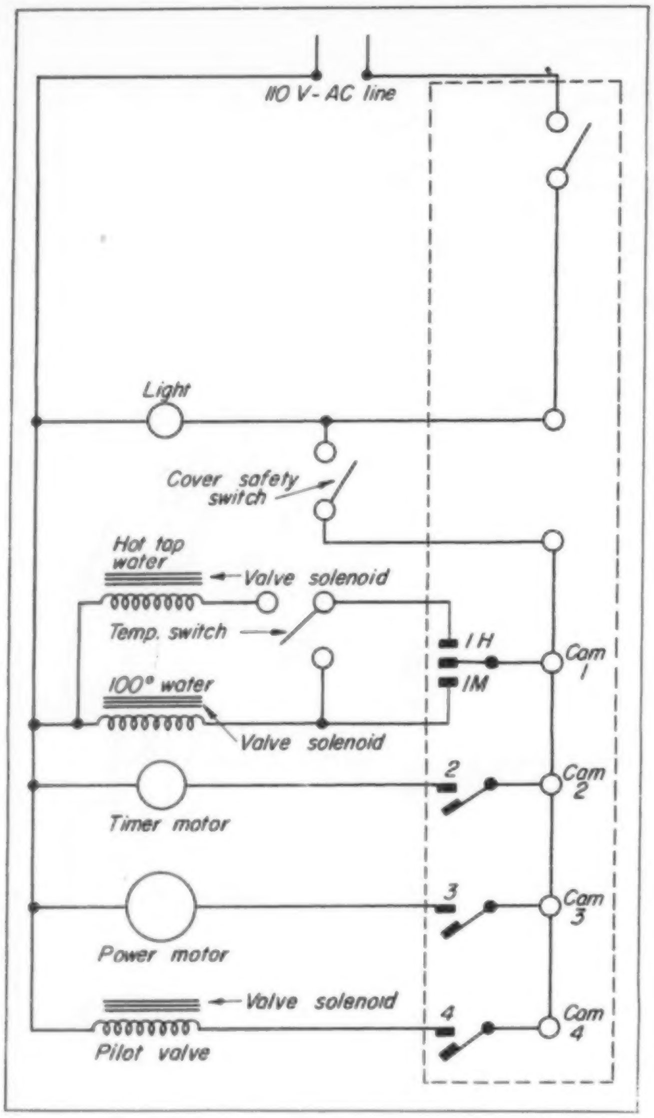


Fig. 4—Electrical diagram of washer cycling, indicating how four cams in timer actuate contacts which in turn actuate various electrical units

the periphery of the basket. On the underside of the basket, ducts lead to the pockets. The balancing action is one in which water at line pressure is valved into the ducts and flung into the pockets by centrifugal force. Obviously, the secret in this scheme is to create a valve which will direct the water into the proper pockets.

This problem was solved by utilization of the valve shown in *Fig*. 2. It comprises a molded-rubber sleeve within which is located a steel sleeve. Pressed into the steel sleeve is a porous bronze bearing in which the tubular basket shaft rotates. An annular water pocket between the rubber and steel sleeves is sealed at the top by contact of the tapered portion of the steel sleeve with annular ridge tops of the rubber sleeve. At the bottom, the pocket is sealed by two O-rings. With the steel sleeve centered, the water pocket is sealed. However, if the steel sleeve is forced off center, it presses against the rubber sleeve on one side, thus creating an eighth-moon shaped opening around the steel sleeve at the other side. Through this opening water squirts up against a deflector plate which directs the water outward horizontally through the ducts on the underside of the basket and, by centrifugal force, up into one of the eight pockets at the basket's periphery. Inasmuch as the force pushing the sleeve off center is created by off-balance of the washer basket, the water is directed into the pocket diametrically opposite the heavy side of the basket and thus effects automatic balancing.

It will be apparent that a short period of time is required for the water emanating from the valve top to travel from there up to the deflecting plate and outward to the entrances of the ducts. To compensate for this lag, the ducts are spirally shaped, as shown in the top view of *Fig*. 3. Actual radial displacement, ninety degrees, is equal to the amount of basket rotation which occurs from the time the water leaves the top of the rubber sleeve valve until it reaches the entrance of its duct.

Oil Reservoir Feeds Bearing

Permanent lubrication of the porous bronze bearing in the steel sleeve is achieved by filling the pocket between it and the sleeve with oil. This is done by keeping the sleeve filled with oil under pressure as the bearing is pressed down into the sleeve.

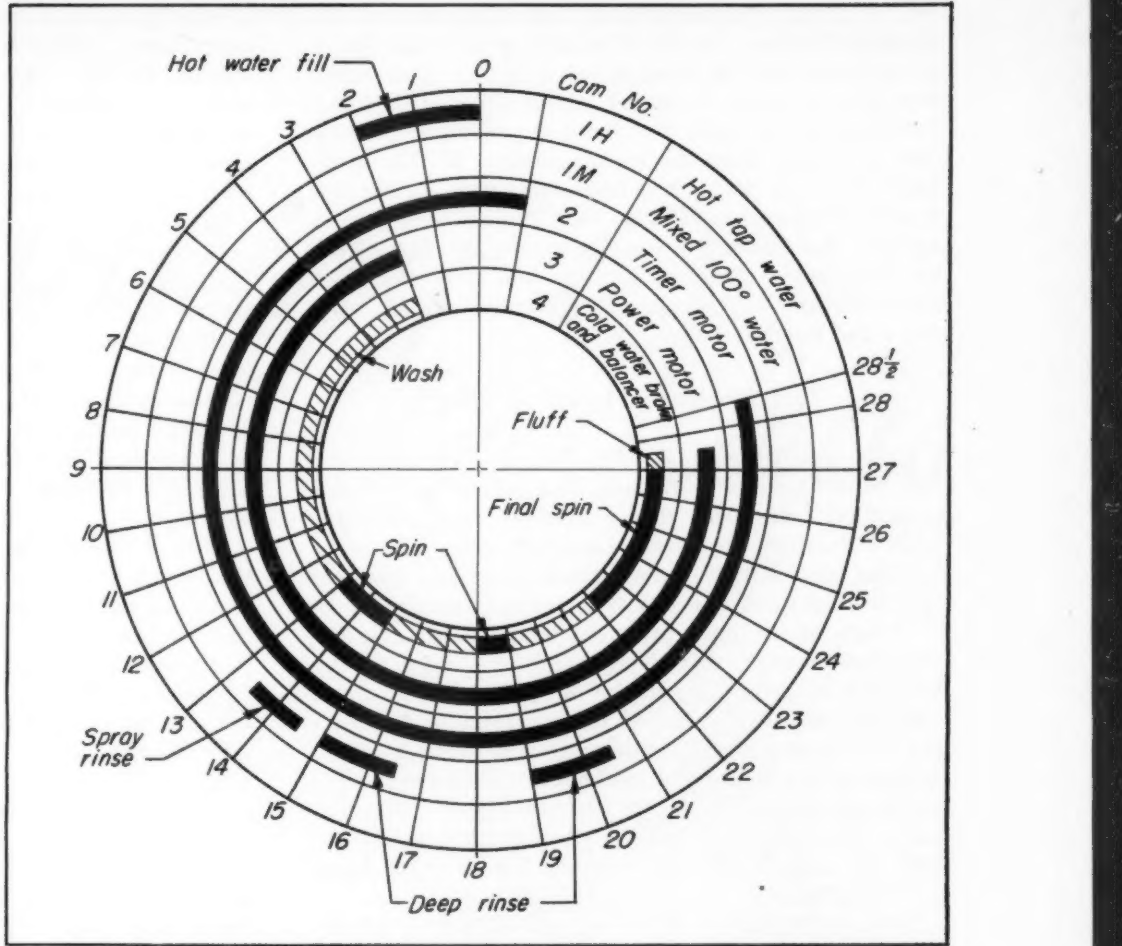
An interesting assembly problem was neatly solved in this pressing operation. It was found that the outside diameter at the lower portion of the bearing was sized as it passed through the top hole of the sleeve, making it too small for a firm press fit with the inside diameter of the middle necked-in portion of the sleeve. This was quickly remedied by making the upper part of the bearing outside diameter slightly larger than the lower part; the respective holes in the sleeve were, of course, proportioned to produce press fits at both locations.

A primary requirement of the machine was an extremely simple shifting mechanism to permit automatic cycling from "wash" to "spin." The mechanism employed not only meets the simplicity requirement but, as mass produced, makes generous use of stamped and die-cast parts. Perhaps a general description of the overall function of the machine will serve best to make clear the shifting mechanism operation and design. Primary units involved in achieving the wash, spin-dry, balancing and shifting actions are clearly shown and identified in the cross section drawing, *Fig*. 2.

When water is automatically drained from the diaphragm unit at the machine base, the coil springs press the top surface of the diaphragm downward, lowering the shifter posts and plates. This action disengages the lower clutch face from the bottom friction surface of the pulley and permits the upper clutch spring to press the upper clutch face firmly against the top friction surface of the pulley (pulley is driven by V-belt direct from constant-speed motor). At this time the inner shaft is held stationary and the outer shaft is spun. Since the basket shaft is mounted in bearings set at a tilt, as the outer shaft spins, the basket describes what might be termed a swiveling-rocking motion, which bounces the soapy water through the clothes.

Next, water is automatically valved—at line pres-

Fig. 5—Right—Chart of washer cycling relates cams and their functions with resulting actions which constitute portions of the entire 28½-minute cycle. Figures around chart periphery indicate minutes



sure—into the diaphragm unit and the three shifter posts raise the shifter plates. This action lifts the upper clutch face off the top friction surface of the pulley and at the same time permits the spring of the lower clutch to press the lower clutch face firmly against the bottom friction surface of the pulley. Thus the outer shaft is held stationary while the inner shaft is spun. As it spins it drives the basket by means of the universal joint. This is the extracting cycle during which water is flung from the clothes by centrifugal action. Bouncing and extracting occur, of course, at the same speed.

Machine Cycled by Cam-Actuated Contacts

Automatic cycling of the machine is accomplished through utilization of a small synchronous motor driving four cams which make or break electrical contacts controlling the power motor and solenoid-operated water valves. An electrical circuit diagram of the cycling is shown in *Fig.* 4, while the cycling itself is charted in *Fig.* 5. A long vertical shaft extends from a dial at the top of the machine to the cam shaft. When the dial is set at the start position, cam No. 2 closes a contact which starts the timer (synchronous) motor. One-half minute later, cam No. 1 contact energizes the hot-water valve solenoid and for two minutes hot water pours into the basket from a spout located at the top, rear-center of the machine. Next, cam No. 3 contact starts the power motor. Inasmuch as the diaphragm unit at the base of the machine is in its drained position at this time, the motor drives the outer basket shaft while the inner shaft is stationary, initiating the "bounce" or wash cycle.

At the 13-minute point of the cycle, cam No. 4 contact energizes the valve controlling the diaphragm. The diaphragm expands upon the entrance of water at line pressure, thus shifting the basket from wash to spin. One-half minute later a portion of cam No. 1 closes a contact which controls a water-mixing valve, and water at 100 F, plus or minus 5 degrees, enters the basket for one minute during the two-minute spin-rinse. At the 15-minute point, cam No. 4 contact de-energizes the diaphragm valve, the diaphragm unit drains, and the machine goes back into its wash action. At this same time, cam No. 1 again acts to valve 100-degree water into the basket for one and one-half minutes. The period from the 15 to 18-minute points of the cycle is termed the wash-rinse or deep-rinse period.

Next, at the 18-minute point, cam No. 4 contact energizes the diaphragm valve, shifting the basket into its spin action again; this time for one minute. At the 19-minute point, cam No. 4 contact de-energizes the diaphragm valve, shifting the basket into "wash." Also, as before, cam No. 1 acts at the same time to valve 100-degree water into the basket. Water enters for one and one-half minutes, and the wash-rinse continues for another one and one-half minutes to the 22-minute point. Final spin is initiated by cam

No. 4 at the 22-minute point and continues to the 27-minute point. At the 27-minute point, cam No. 4 de-energizes the diaphragm valve again. This time, however, no water is valved into the basket, and the bouncing action fluffs the damp-dry clothes so they can be picked from the basket easily. If this "fluffing" were not done, the clothes would lie within the basket in a doughnut-shaped ring, having been packed against the basket wall by centrifugal action during final spin. Final cycling actions are, of course, the stopping of the timer and power motors by cams No. 2 and 3 respectively.

Test Machines Placed in Field

Prior to putting the machine into mass production, one hundred units were built and placed in selected homes on field test. These field-test machines had basket hubs of sand-cast aluminum, spun aluminum baskets and Kirksite die-formed balancing pockets spot welded in place. *Fig.* 3 shows the hub and basket design of the mass-produced model. Primary differences between this design and that used in the field-test machines are in the methods of production. The hub as mass produced is an aluminum die casting, the basket shell members are deep-drawn 52S-O aluminum sheet, and the pockets are die-formed 3S-O aluminum sheet spot welded to the basket. Incidentally, all screws used to fasten basket members to the hub are cadmium-plated steel of the hexagon-head, self-tapping type.

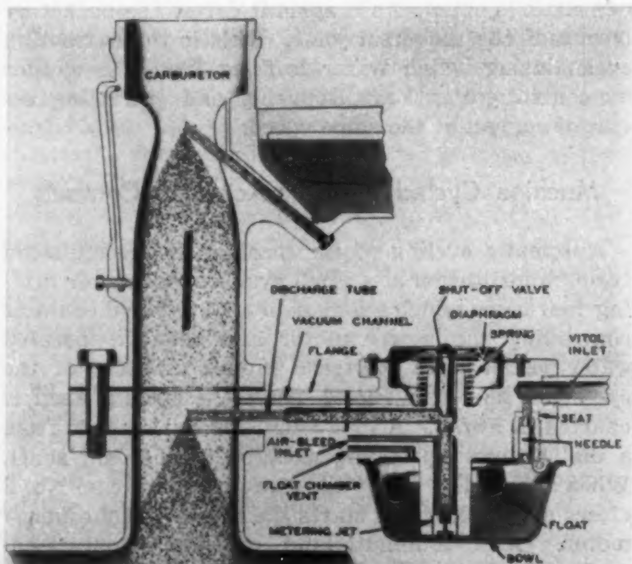
Base frame in the field-test machines was a sand casting, whereas in mass production it is fabricated of steel stampings which are spot welded together for positioning, followed by arc welding for strength. Valves, fittings, fastenings, motors, and other electrical components in the mass-produced machine are all standard stock items. In addition, wherever possible, parts are produced by stamping or die casting, both top-speed production processes.

Selection of materials has also been conducted with an eye cocked toward facility of processing. The various studs, posts, etc., are all free-machining X1112 steel and are produced on screw machines. SAE 1010 sheet steel is used throughout for all steel stampings, as well as for the deep-drawn top unit of the cabinet. The flat, star-wheel shaped clutch springs are stamped of 1070 or 1080 steel, quenched and tempered to a hardness of 44 to 48 Rockwell C. They are cadmium plated all over to guard against corrosion.

One of the few iron castings in the machine is the clutch pulley unit. Clutch plates are plain carbon steel and are ground flat in the areas contacting the friction disks. The fluted center cabinet unit, which constitutes the washer tub, is brake-formed of enameling stock steel and porcelain enameled. Aluminum sheet is used for the lower cabinet unit which shrouds the power and control mechanisms of the washer. Finished in synthetic enamel, it is held in place by two quick-acting aircraft type fasteners which permit simple and rapid removal of the shroud for servicing. All water lines are brass tubing and connections are made with self-flaring fittings. The basket-shaft cap (*Fig.* 2) is molded of plastic-impregnated Fiberglas.

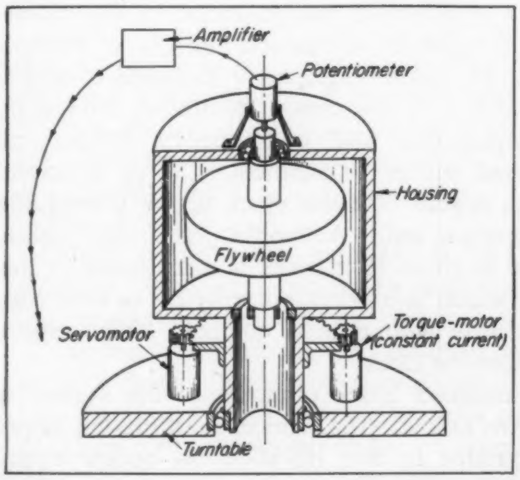
Antidetonant Injection

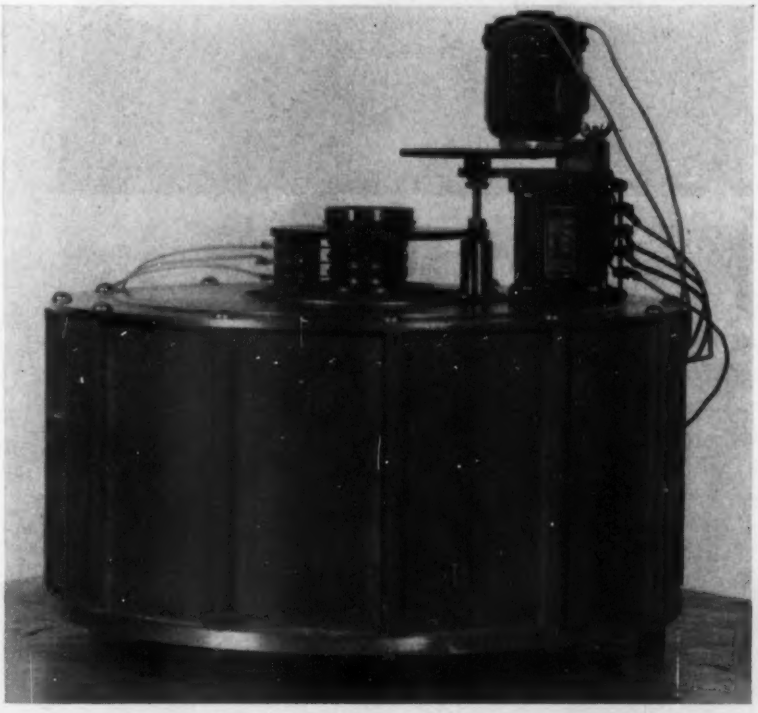
DESIGNED to automatically add an antidetonant fluid to the gasoline-air mixture entering the combustion chambers of an engine, the Vita-Meter unit manufactured by Thompson Products Inc., Cleveland, operates only when needed to eliminate detonation. The unit, right, functions at approximately the same load as the power or economizer jet in a standard carburetor. In operation, Vitol (a mixture of water alcohols, inhibitors and tetraethyl lead) flows from a supply tank to the Vita-Meter assembly. The flow is into the float chamber, then into the metering jet where the solid fluid is broken up into a spray by air entering the small holes in the wall of the metering jet.



The Vitol-air mixture flows up through the diaphragm shut-off valve, to the spacer flange and into the inlet manifold as a spray. Introduction of the fluid coincides with high engine load, being automatically controlled by engine manifold vacuum acting on the diaphragm of the shut-off valve. Thus, the octane number of the fuel is raised during the 10 or 20 per cent of the time when more power is required, permitting the use of a lower octane gasoline.

Scanning the field for Ideas





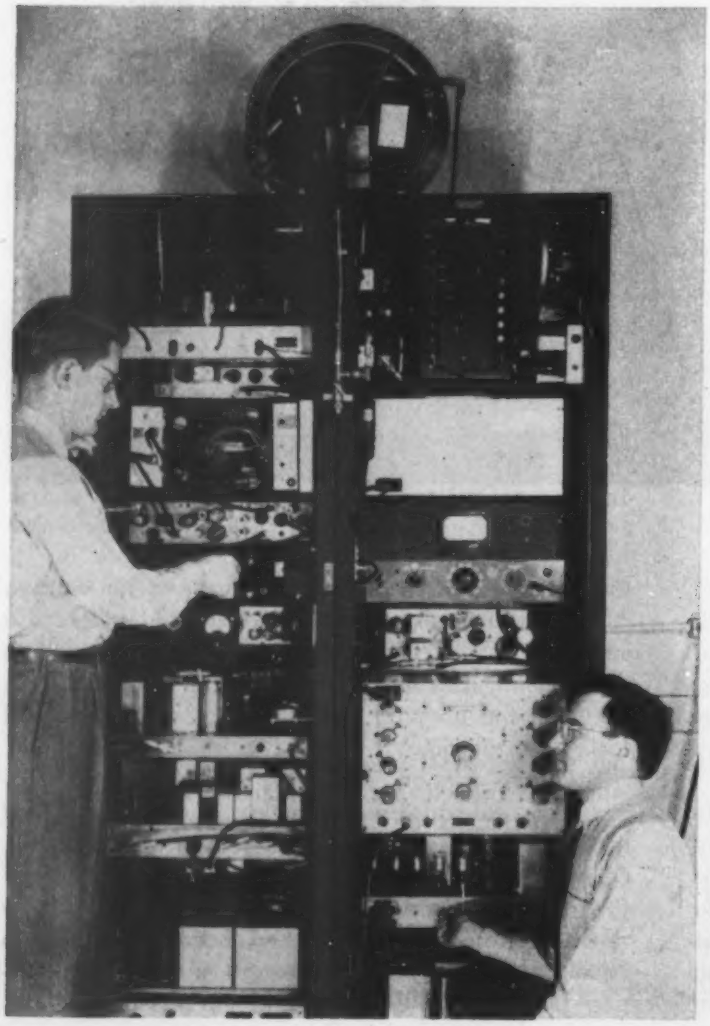
Bearing friction may be reduced by using the servo-controlled follow-up system shown in the photograph and schematic sketch above. This system might be applied to tension rolls on paper or textile machinery as well as to gimbal bearings of gyroscopes. Resulting from research at Cambridge Field Station, Air Materiel Command, this device was developed in an effort to minimize friction effects by adding friction-compensating servomotors rather than trying to improve further upon the bearings themselves which had already been the subject of considerable research.

It is assumed that the ball bearings are subjected to vibration and therefore do not transmit any static friction torque. Housing for the flywheel is driven by a servomotor in such a manner that the relative motion between the housing and wheel is held to a minimum. This is accomplished through a potentiometer which converts the angle between the housing and wheel into a voltage. This voltage is fed through slip rings and an amplifier into the servomotor. In this way, friction effect between the housing and flywheel is eliminated and friction between the housing and platform is compensated for by the servomotor.

Negative friction, however, was observed during tests caused by the action of the servo and resulted in an increase in speed of the flywheel. Curves for speed variations of the servomotor show that it takes more time to speed up than to slow down. Therefore, the housing has a tendency to accelerate the flywheel through the bearing friction between the housing and the wheel, the fric-

tion being constant regardless of speed.

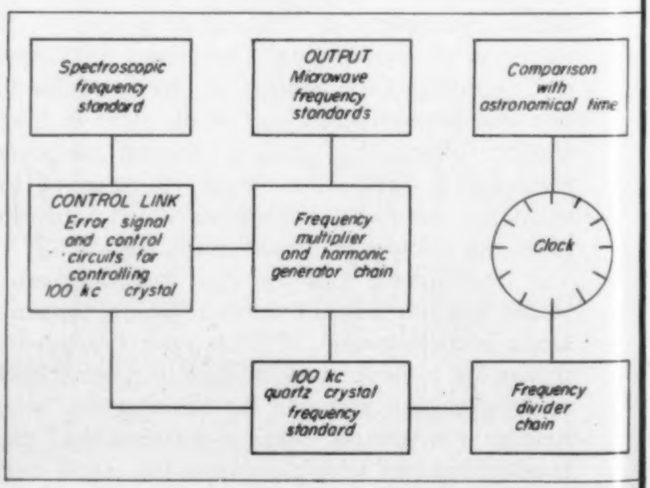
This negative friction effect is eliminated in the system illustrated by the addition of a constant-torque (constant-current) motor which operates through a relay whenever the servomotor is rotating. Torque is adjusted to compensate for the friction on the drive.



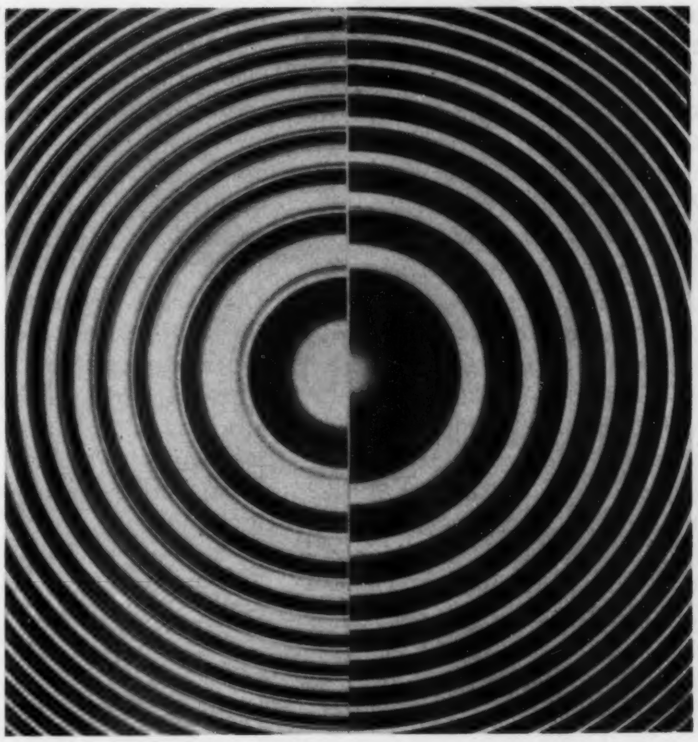
Atomic clock, left, based on a constant natural frequency associated with the vibration of atoms in the ammonia molecule, is a new primary standard of frequency and time. Based on a principle developed at the National Bureau of Standards microwave research laboratory, the clock has a potential accuracy of one part in a billion or more, whereas the length of the mean solar day fluctuates as much as one part in 20 to 30 million.

Construction of the clock may be seen in the back view of the equipment at left. Some of the instruments shown are for measurements and tests of performance. Actually, the circuits essential to the operation of the atomic clock could be condensed into one of the two cabinet racks. Equipment includes a crystal oscillator, a frequency multiplier, frequency discriminator, and a frequency divider—all housed within the cabinets. On top is mounted a special 50-cycle clock and a waveguide absorption cell. Ammonia gas under a pressure of 10 or 15 microns is maintained in this cell which is a rectangular ½ by ¼-inch copper tube wound in a compact 30-foot spiral around the clock.

Simplified block diagram of the system is shown below. The fundamental driving signal originates in the 100-kilocycle quartz-crystal oscillator. The frequency-multiplier and harmonic-generator chain then multiplies this signal up to microwave frequencies by means of vacuum-tube circuits and silicon-crystal diodes, providing output signals throughout the microwave range. Frequency-discriminator circuits in the control link then compare the



frequency of these signals with the ammonia frequency standard. After the microwave signal is exactly tuned to the frequency of the spectrum line, any tendency to drift on the part of the quartz-crystal oscillator will cause the discriminator circuits in the control link to send an "error signal" back to the oscillator, maintaining it at the proper frequency. The crystal oscillator is thus locked to the invariant frequency of the ammonia line. A frequency divider chain then drives a synchronous-motor clock, first reducing the stabilized 100-kilocycle signal to the clock frequency.



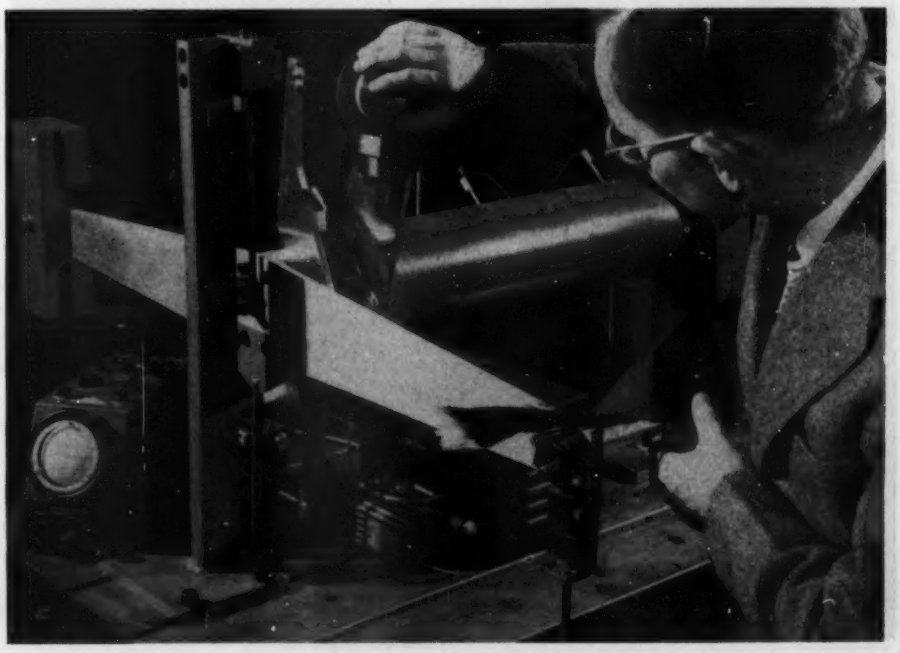
More accurate measurement would be possible if the wavelength of the green radiation of mercury isotope 198 were used as the standard of length. Its spectral lines represent the ultimate in sharpness and intensity that can be obtained from any atom, either natural or artificial, according to Dr. William F. Meggers of the National Bureau of Standards. He has measured the wavelength of mercury 198 radiation with an accuracy of one part in a hundred million, one part in a billion being theoretically possible.

Shown at right are interference fringes of mercury 198 (right) compared with those of natural mercury, showing the clearer definition of the former. Radiation is obtained by exciting a few milligrams in a glass tube using high-frequency radio waves. Because greater precision, reproducibility, and convenience are provided by mercury 198 than from either the standard meter or the red line of cadmium, the bureau presented it for consideration as the world's primary standard of length at the International Conference of Weights and Measures meeting in Paris in October.

Development of such a standard would be of inestimable value. For example, more accurate determination of measurement of dimensions, planeness and expansion of parts will be possible.

Detection of changes in weight as small as one part in 100,000 have been demonstrated with the elastic drift measuring machine illustrated below. Developed at the Westinghouse Research Laboratories, this device is expected to aid in the design of more accurate and sensitive torquemeters needed for measuring power delivered by airplane propellers, jet engines and other rotating machinery.

This twist detector employs a one-inch steel shaft 25 inches long, bolted to the center of a cross arm at one end and rigidly fixed at the other. Sensitive electrical contacts are able to measure a movement at the surface of the shaft of less than one-millionth of an inch. Contacts close when the shaft twists and give a highly accurate reference point from which to measure the



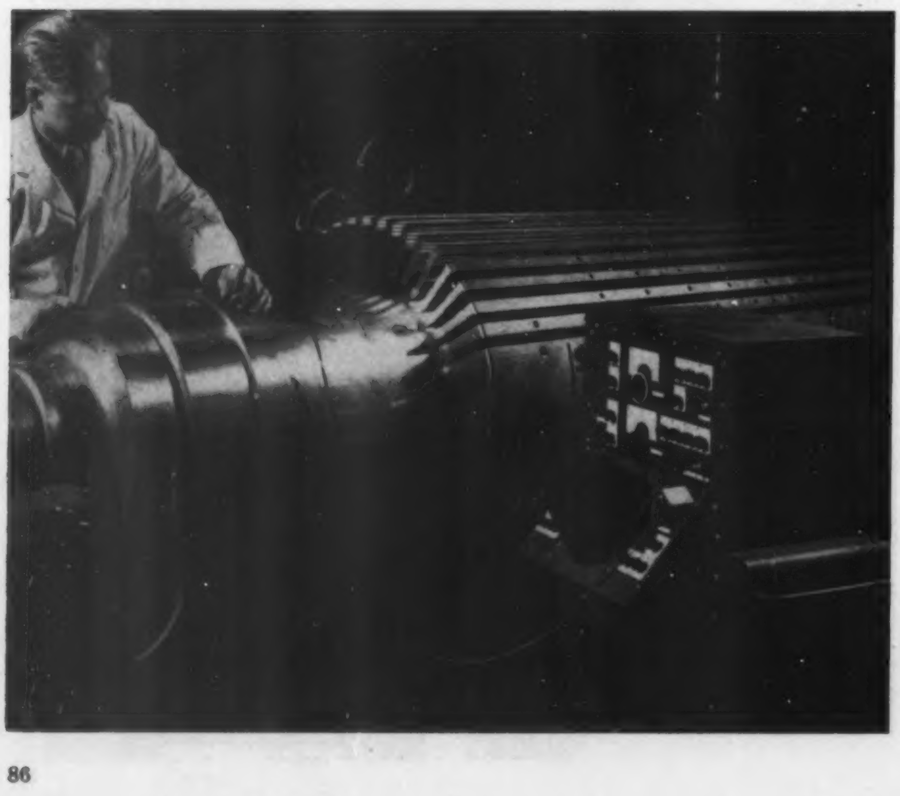
amount of twist resulting from applied weights. This is measured in terms of the distance a minutely calibrated gage must move in order to reclose the electrical contacts again. Weights are then removed in order and the twist measured in reverse direction.

In the illustration, the amount of deflection caused by the weight of a feather is being measured. An ideal shaft should show the same amount of twist during removal of weights as it did during their application. Actually there is a slight variation due mainly to elastic drift. Finding a material that will reduce this variation to the lowest possible is a major aim of the project.

Examination for flaws in steel with an ultrasonic "stethoscope" is shown below being applied to a Westinghouse generator shaft. Suitable for testing metal parts ranging in size from 0.25-inch to 30 feet in thickness, the technique transmits ultrahigh-frequency sound waves through the part being examined.

Using a crystal similar to that used in phonograph pick-up arms, electrical impulses are changed into sound waves. When projected through the metal these waves are reflected back to the crystal either from the opposite side of the metal or from any flaws such as cracks, cavities or foreign particles that may be present. Changed back into electrical impulses, these reflections appear as bright vertical lines on the viewing screen of an electronic receiver.

By measuring the time it takes the sound waves to bounce back to the crystal, the exact location of any flaw may be located. Based upon the same principle as radar, the process is called ultrasonic instead of supersonic because supersonic refers to "speeds faster than sound" whereas ultrasonic refers to sound waves at frequencies beyond the range of human hearing. Method reveals quality of metal as accurately as X-rays. Practical limitation of X-rays, however, limit their use to metal thicknesses under 6 inches.



Portable power unit, above, operates on the chain tong principle. Drive chain has patented quick-action connecting links for lengthening to accommodate work of larger diameter. Designed by the Kinmount Manufacturing Co., the tool can turn round or nearly round work for operations in the field such as welding, cutting, grinding, painting and similar tasks. Universal motor powers the unit in either direction through the chain and roller drive. Quick acting rack positions drive sprocket to desired chain tension. Weighing 71 pounds, the unit can drive the work at any desired surface speed between 3 and 26 inches per minute.

Planetary Gearing

. . . analysis based on simple forces and moments short-cuts tedious algebra and provides clear picture of relative motions

By W. P. Michell

Chief Development Engineer
Spicer Manufacturing
Division of Dana Corp.
Toledo, O.

IN REFERRING to the standard literature on planetary gears the author has been struck by several facts. In the first place there is no complete reference work on the solution of the numerous planetary combinations. Furthermore, available solutions are more complex than the problems seem to justify. Solutions involving speeds with plus and minus sign conventions, compounding equations from one element to the next, etc., leave one slightly dazed when trying to visualize what is going on. Finally, the loads needed to design bands and clutches are not touched on.

A method which to the author's knowledge has not been published permits fast solutions with no complex equations and affords, while solving, a picture of the loads and speeds, as well as their directions. Solutions are reached with one or two lines of calculation, as compared to the lengthy derivations in reference works.

Briefly the method is as follows:

1. With the planetary standing still, scan the system for the forces involved, considering gears as levers
2. Set up the equation relating unknown torque to input torque and solve for ratio
3. Speed ratio is, of course, the reciprocal of this torque ratio.

SCANNING: Taking as an example a simple planetary, *Fig.* 1, consider the static forces when torque is applied to the input with the output locked. It is known that these forces are the same as the running forces. Let right-hand (clockwise) rotation be considered as forward direction. It can be seen that with input torque applied to arm *A*, sun gear *B* locked to frame, and ring gear *C* the output:

1. Torque on *A* produces a force at center of planet *D*

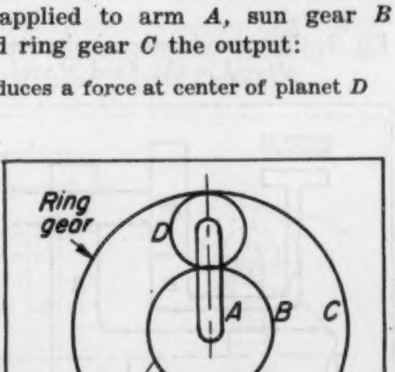


Fig. 1 — Simple planetary unit with fixed sun gear, driving ring gear, and driven planet arm. Analysis treats planet D as a beam in equilibrium between driving, driven, and reactionary forces

SOLUTION BY PLANET TOOTH FORCES: Arm A, driving, exerts force at center of gear D, *Fig.* 1. This center being a free bearing, the force divides equally between the outer and inner teeth of the planetary D. Force on the bearing is T_a/A, where T_a is the input torque to arm. Force on the outer teeth is $\frac{1}{2} T_a/A$.

Torque on the output ring is the force multiplied by the radius of the ring:

$$T_c = \frac{1}{2} \times \frac{T_a}{A} \times C$$

from which

$$\frac{T_c}{T_a} = \frac{C}{2A} = \text{Ratio}$$

Because $A = \frac{1}{2}(B + C)$, this can readily be converted to the usual form: Ratio $= C/(B + C)$

SOLUTION BY MOMENTS: With sun gear B fixed, *Fig.* 1, take moments on planet D, about pitch point of D to B. Driving moment is the force at center of D, due to planet arm, multiplied by the radius of D. The balancing moment to this is the force on ring gear C multiplied by the diameter of D. These two moments must be equal, since no other moments act on D. Setting up the equation and solving for force on C:

$$\frac{T_a}{A} \times D = \frac{T_c}{C} \times 2D$$

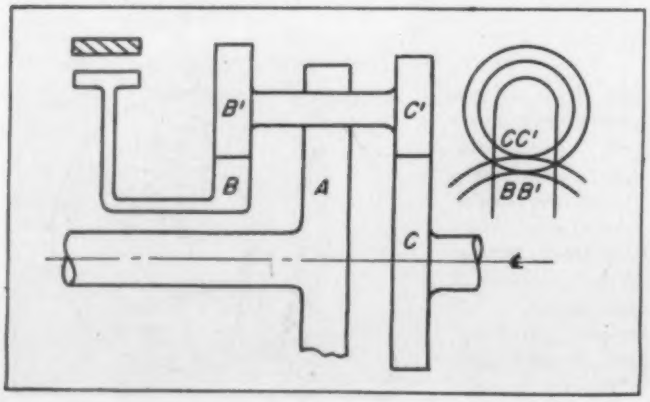
from which

$$\frac{T_c}{T_a} = \frac{C}{2A} = \text{Ratio}$$

2. Since D is free on arm, the tooth loads D to C, and D to B, are equal
3. Both these tooth loads are forward driving forces
4. The ring gear will go forward
5. The sun gear will *try to* go forward
6. The supports will resist sun gear torque with a backward push or reaction
7. The input motor on arm A exerting forward torque has a forward reaction, i.e., its frame receives a forward push from the supports
8. Planet D being stalled, take moments of forces on it about pitch point DB, or about pitch point DC, or about planet center; in each case the moments must balance
9. Again considering planet D stalled, the opposing forces on it must be in balance regardless of distance from center; the forces driving it, as a body, in its orbit around the center of the system are equal to the resisting forces. This would be true even with a compound planet on which forces are applied at several diameters
10. Planet D is in balance with regard to torques applied about its axis; this would also be true if it were a compound planet.

No large part of the foregoing analysis is needed to solve this simple setup, but any of the ideas may be drawn on in solving more difficult jobs, or in checking a solution obtained by other means, or in solving relationships not shown in texts. By careful scanning, simple solutions and actual saving of much time can be achieved.

Fig. 2—Compound external planetary unit of the type employed in the Ford Model T transmission



SOLUTIONS: In solutions, the number of teeth in any gear is taken to represent its radius (twice the number is used for diameter). Corresponding radius of a planet carrier is then the number of teeth on a gear of that pitch radius (or 2 × radius × diametral pitch). Also T_a, T_b, etc., represent the torque transmitted by part A, B, etc., and T_a/A, the torque transmitted by gear A divided by its radius, is the force at the pitch circle (the tangential driving force) of a gear having A number of teeth. Ratio is the factor by which input torque is multiplied to find output. Input speed, divided by the same ratio, gives output speed.

As examples, four methods of solving the planetary in *Fig.* 1, using static forces and different concepts, are presented in parallel columns on this and the next page.

EXAMPLE 1: What torque is required of a clutch to lock the planetary shown in *Fig.* 1, for direct drive, clutching sun B to A? Torque in ring C is now same as in arm A, or $T_c = T_a$. Again imagine the system stalled and C exerting force on outer teeth of D. This will be T_c/C, or T_a/C (since $T_c = T_a$). This tooth pressure is balanced by pressure B (see under item 8 on this page) and gives torque $T_b = (T_a/C)B$ which is the torque on the clutch which locks B to A.

EXAMPLE 2: In the compound external planetary shown in *Fig.* 2, arm A drives, sun B is locked, and sun C is driven. This design was used in the Ford Model T transmission.

Again think of the compound planet as a lever and scan; the fulcrum is at contact BB'; force is applied at the arm stud, and resisting force at contact CC'.

If C is larger than B the output force on C is in forward direction.

If C is smaller than B, the output is reverse.

Solution by Reactions: The driving motor will produce a reaction on the supports equal to input torque. Study will show that the supports tend to push the motor frame in the forward direction.

The planetary frame or case may receive either a backward or a forward reaction or push from the supports. If backward, the planetary has decreased the input torque by that amount. If forward, the planetary has increased the input torque. If the backward reaction exceeds the forward reaction to input, the planet system has a reverse output.

In *Fig.* 1, with arm A driving, scanning shows that the tooth load from planet D to sun gear B (which is anchored to frame) produces a backward *reaction* (from B to D), and the output torque must be less than the input, as the input reaction is reduced by this amount. Expressed in symbols, $T_a - T_b = T_c$ (algebraic sum of reactions equals output torque).

Scanning has shown that the reaction torque decreases the input torque and that the output runs forward, so no rules or conventions for positive or negative values are used in setting up this equation.

Tooth load on B is the same as on C since the planet D has a free bearing; this tooth load is T_c/C, and the reaction torque of B is then $(T_c/C)B$. Therefore

$$T_a - \frac{T_c}{C} \times B = T_c$$

Solving,

$$\frac{T_c}{T_a} = \frac{1}{1 + \frac{B}{C}} = \frac{C}{C+B} = \frac{C}{2A} = \text{Ratio}$$

Any of these terms is a solution.

The imagined lever must also be in balance about contact CC'. With forward drive (C larger than B) the arm force is resisted by a force tending to drive sun B backward, but B is locked and this gives a reaction which adds to the input torque (the supports push the planetary frame forward). Scanning thus shows that the design cannot be used for overdrive, except by driving from C.

Solving by concept of moments on planets:

$$\frac{T_a}{A} \times B' = \frac{T_c}{C}(C-B)$$

$$\frac{T_c}{T_a} = \frac{C}{A}\frac{B'}{(C-B)} = \text{Ratio}$$

What torque must the friction band on sun B hold, and at what speed would sun B revolve if band were released with output sun C stalled?

Both these answers are found by considering sun B the output and holding sun C. Consider the planetary countershaft as a lever with a fulcrum at pitch point CC', input force at bearing on outer end of arm A, and output force on pitch point BB'. Then

Solution by Balance of Forces on Planet: Since planet D is not moving (or accelerating when running) all static forces on it must be in balance. Force from arm A pushes it to right, while forces from sun B, and from ring C, push it to left, therefore (*Fig.* 1):

$$\frac{T_a}{A} = \frac{T_b}{B} + \frac{T_c}{C}$$

But

$$\frac{T_b}{B} = \frac{T_c}{C}$$

since D is in balance on its axis. Therefore

$$\frac{T_a}{A} = \frac{2T_c}{C}$$

and

$$\frac{T_c}{T_a} = \frac{C}{2A} = \text{Ratio}$$

$$\frac{T_a}{A} \times C' = \frac{T_b}{B}(C-B)$$

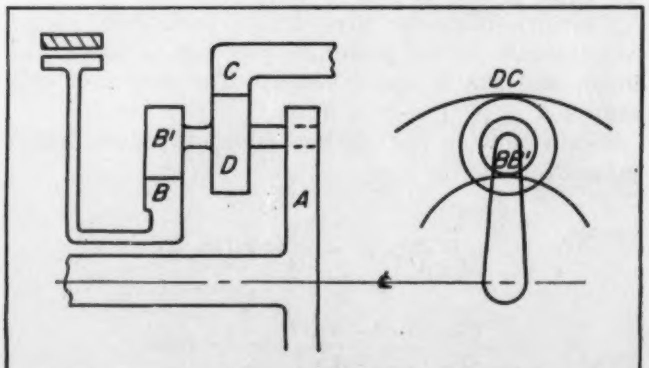
$$\frac{T_b}{T_a} = \frac{B}{A} \times \frac{C'}{(C-B)} = \text{Ratio}$$

It is readily seen that sun B tends to revolve backward if sun C is driven forward. Torque on B is input torque times the foregoing ratio, and speed of B, if sun C is stalled, is input speed divided by the same ratio.

Example 3: A compound internal-external planetary is shown in *Fig.* 3; arm A drives, ring C is driven, and sun B is locked. Scanning, C, will be driven forward and it is simplest to take moments on the compound planet about the point where B' contacts B (think of the compound planet as a lever with loads at contacts DC, BB' and at arm stud). Then

$$\frac{T_a}{A} \times B' = \frac{T_c}{C} \times (D + B')$$

Fig. 3—Compound internal-external planetary unit. With fulcrum at pitch point BB', moments due to forces at arm stud and at ring gear C must balance



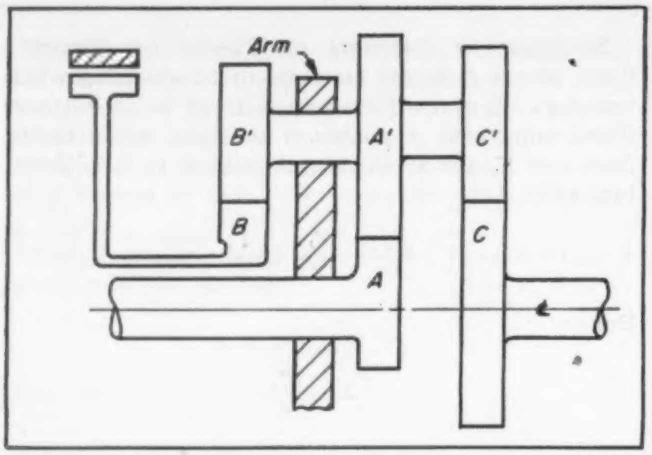


Fig. 4—Compound external planetary unit with floating arm which revolves idly while sun gear A drives and C is driven, gear B being fixed

and

$$\frac{T_c}{T_a} = \frac{B'C}{A(D+B')} = \text{Ratio}$$

EXAMPLE 4: In the compound external planetary, *Fig.* 4, sun A drives, sun B is locked, and sun C is the output.

Scanning the design, it is again seen that the ratio can be solved by taking moments of forces on the countershaft. Using pitch point BB' as fulcrum, moments of forces at pitch points AA' and CC' must equal each other. By observing the direction of these forces and the lengths of the lever arms, it can be seen whether the design will produce an overdrive, an underdrive, or a reverse output, all of which are possible. Solving:

$$\frac{T_a}{A} \times (B-A) = \frac{T_c}{C} \times (B-C)$$

$$\frac{T_c}{T_a} = \frac{C(B-A)}{A(B-C)} = \text{Ratio}$$

Torque on sun B and its cut-loose speed can be derived by the same means as in EXAMPLE 2.

The planet carrier or arm which carries the planet countershaft will revolve when this type of external planetary is functioning, and it is necessary to know its speed. It can be seen that this speed would be the same if output gear C were removed.

Consider that the arm which holds the planet countershaft is the power output, sun A again the input, and sun B again locked. The radius of this arm is $A + A'$ ($= B + B' = C + C'$).

Again solving by taking moments about pitch point BB',

$$\frac{T_{arm}}{A+A'} \times B' = \frac{T_a}{A} \times (B-A)$$

$$\frac{T_{arm}}{T_a} = \frac{(A+A')(B-A)}{A \times B'} = \text{Ratio}$$

Divide input speed of sun A by this ratio to find speed of the arm.

EXAMPLE 5: Taking the Buick drive, *Fig.* 5, (See also MACHINE DESIGN, March, 1948, Pages 124 and 180), the data are as follows: B has 23 teeth, C has 28 teeth, D has 28 teeth, E has 18 teeth, and G has 79 teeth.

Forward Speed. Sun gear C is driving, sun gear B is locked, and planet arm A is driven. Input speed is 1000 rpm.

Scanning the diagram will show: The output is forward; the reaction on B causes a forward push, like that on the motor supports, therefore the torque on B adds to the input torque; tooth pressure from C goes through gears E and D without change. Therefore, reaction torque on B is

$$T_b = \frac{T_c}{C} \times B$$

and output torque is

$$T_a = T_c + \frac{T_c}{C} \times B = 1.82\ T_c$$

To find speed of ring gear G, consider it as the driven member and find its torque. Again scanning the diagram for forces: G goes forward; tooth pressure on G equals that on B; reaction to torque on B is in the same direction as the reaction to input torque, and adds to it. Reaction torque on B is

$$T_b = \frac{T_g}{G} \times B$$

Therefore

$$T_c + \frac{T_g}{G} \times B = T_g$$

and

$$T_g = \frac{T_c}{1 - \frac{B}{G}} = \frac{T_c}{1 - \frac{23}{79}} = 1.41\ T_c$$

Reverse Speed. C is driving, G is locked to the frame, and planet arm A is driven. Scanning, A revolves backward, reaction on G is opposite to motor support reaction, tooth pressure is unchanged from C to G, and reaction torque on G is

$$T_g = \frac{T_c}{C} \times G$$

Output torque is

$$T_a = T_c - \frac{T_c}{C} \times G = -1.82\ T_c$$

The minus sign indicates reverse direction.

To solve for speed of B, with G locked and C driving, scan the diagram again in the static condition. Clockwise input torque on C puts clockwise torque on G and counterclockwise torque on B, so B reverses. Also the reactions to torque in at C and out at B are in the same direction and oppose the torque locking G.

One concept is that due to the balance across

the gear D, the clockwise torque imposed on D by input is split evenly in reactions on B and G. (The only tangential forces tending to move D around the system center are at contacts DG and DB, and these forces must be equal and opposite.)

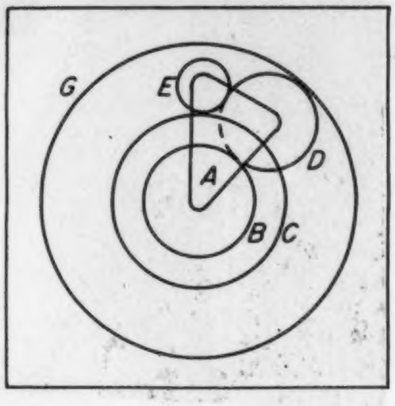


Fig. 5—Planetary unit employed on Buick Dynaflow drive provides two forward speeds and one reverse, by proper application of clutches and brake bands

Balancing Tangential Forces

A more easily understood solution employs the balance of tangential forces on D. All expressions are quantitative, i.e., nondirectional. Force at DE turns D clockwise, forces at DB and DG tend to turn it counterclockwise, therefore

$$\frac{T_c}{C} = \frac{T_g}{G} + \frac{T_b}{B}$$

for static balance of D. Also, for reverse

$$\text{Output} = \text{Reaction minus Input}$$

$$T_b = T_g - T_c$$

Solving,

$$T_b = T_c \frac{G}{C} - T_b \frac{G}{B} - T_c$$

$$T_b = T_c \frac{\left(\frac{G}{C} - 1\right)}{\left(1 + \frac{G}{B}\right)} = 0.41\ T_c$$

Still another solution is by reactions; the reaction at G opposes the input reaction and the output can be seen to be reverse.

$$T_g - T_c = T_b$$

But T_g from previous solution is 1.41 T_c (with B locked and G driven), therefore $1.41\ T_c - T_c = 0.41 \times T_c = T_b$.

It can be seen that in most cases the solution is most easily arrived at by solving directly for the static reaction, or by taking moments about the reaction element.

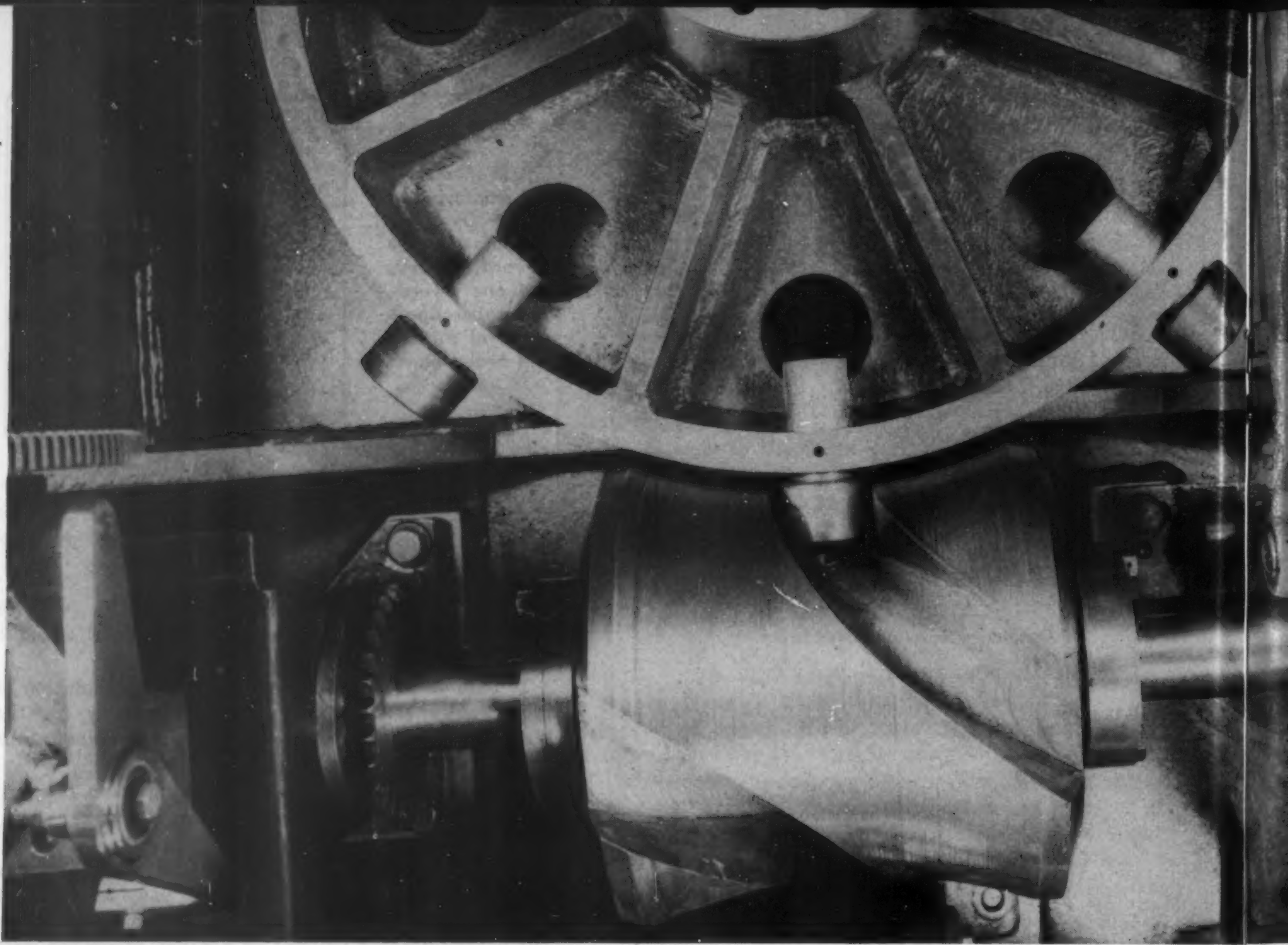
It is frequently found that working from the output torque (reversing the direction of power flow) aids in setting up the equations.

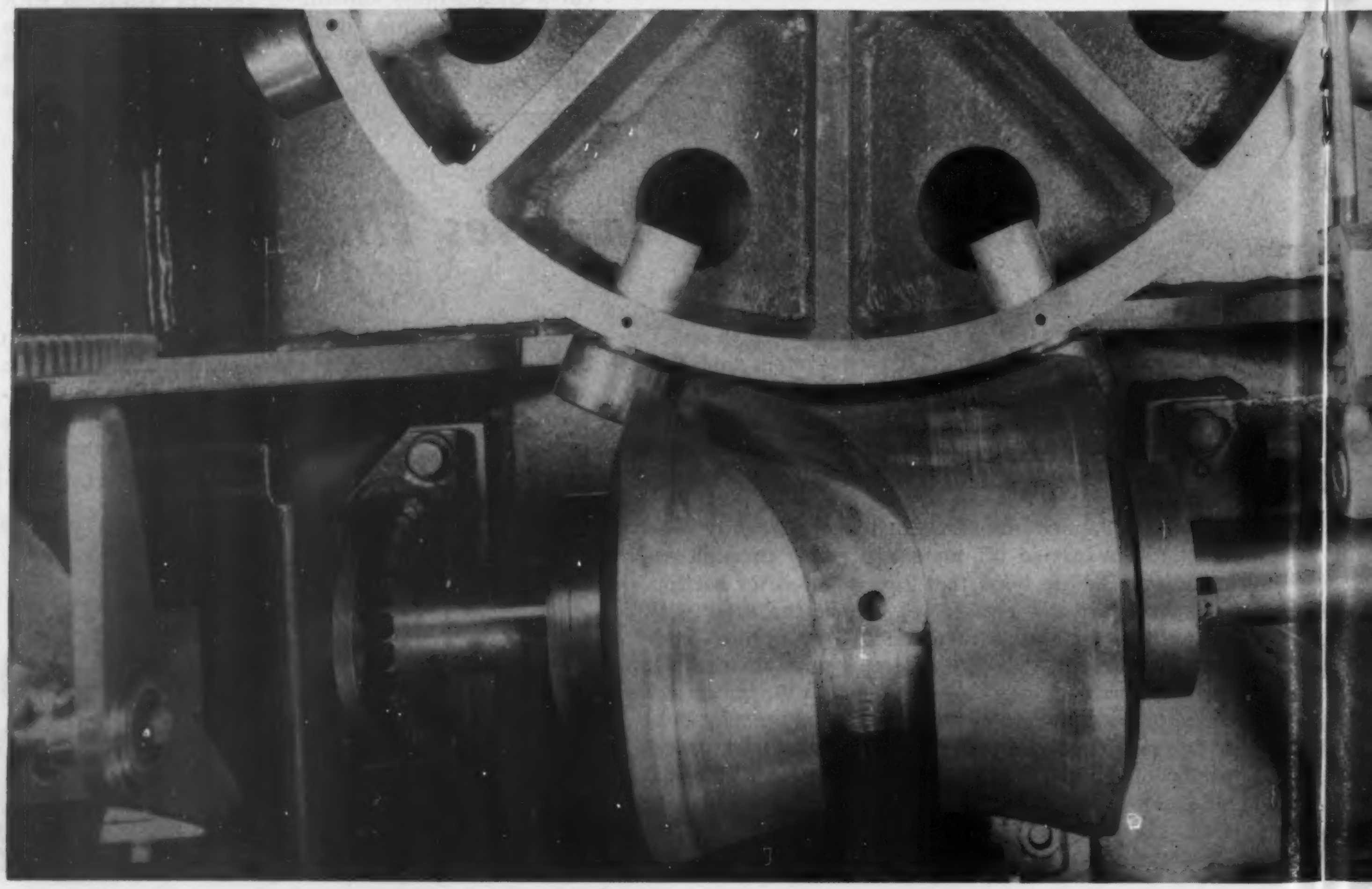
Methods of solution discussed in the foregoing offer several advantages. They are easy to derive on the spot without consulting references, they short-cut a considerable amount of algebra compared with other methods, and they carry a picture of torques and forces which eliminates errors due to misplaced directional signs.

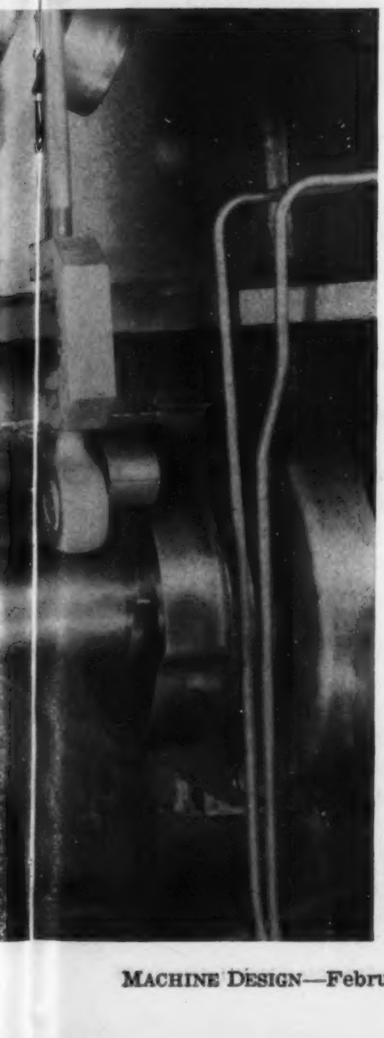
Warm Air Drier Improves Efficiency

SPEEDING removal of moisture from 60-inch paper board, a supplementary drying system installed by the Durham Paper Board Co., Riegelsville, Pa., has resulted in a 10 per cent increase in production. Large volumes of warm air at high velocity are discharged through perforated tubes running longitudinally between the steam drying drums of the paper machine. Vapors are absorbed more readily and moist air is carried off more efficiently through exhaust fans in the hood that covers the drier section.

Paper board enters the wet end of the drier with a moisture content of about 40 per cent and after passing through the 35 steam drums, leaves the drier with about 6 per cent moisture. Warm air for the auxiliary drying system is heated to 175 F in a Dravo Counterflo direct-fired heater with a capacity of 1,500,000 Btu on No. 5 fuel oil. Normal air-handling capacity of the heater can be increased from the rated 17,000 cfm by a booster fan in the air supply duct to the heater. Each of the eighteen 5-inch tubes is 70 inches long, running the full width of the drier. Perforations are spaced about an inch apart in rows along three sides of each tube. Uniform discharge of warm air along the length of the tubes is achieved by varying the diameter of the holes.







Indexing with Concave Barrel Cams

How to design cams which index turrets at speeds faster than those feasible with other mechanisms

By R. J. Jacobs

Chief Engineer

Mercury Engineering Corporation

Milwaukee, Wis.

DESIGNED specifically for indexing high-speed machine turrets, a newly developed concave barrel cam—the Mercury cam—permits indexing at rates heretofore unobtainable by conventional mechanisms such as the Geneva and the ratchet wheel. Successful indexing by this method begins where the Geneva usefulness ends and where the ratchet would be cumbersome and expensive. Turrets having outside diameters of 24 to 60 inches and weighing from 200 to 2000 pounds may be indexed from 60 to 100 stations per minute by this cam mechanism. The number of index stations on the turret may range from 8 to 24.

Drive from cam to turret can be direct or through a follower wheel located on the turret shaft. Standard needle-bearing cam followers, one for each index station, are located radially on the turret (or follower wheel) and ride in the cam track as shown in *Figs.* 1 and 2. During the dwell period, the follower is held in positive register by the track, and no auxiliary mechanism such as locating pins or wedge locks is necessary. The entire installation is extremely durable because of the elimination of backlash, knuckles and links. There is no need for adjustment or take-up after initial installation. Further, the unit is compact and lends itself to the general conformity of most machinery design.

Fig. 1—Left, above — Eight-station, shockless indexing with concave barrel cam. Cam is shown at end of dwell period

Fig. 2—Left—Cam of Fig. 1 after rotation to mid-index position

An important feature of the cam is its flexibility in design with regard to motion and time. Any motion curve, such as constant acceleration, simple harmonic, etc., can be designed into the cam. The amount of dwell per cycle can also be varied. Whereas the Geneva is limited to the timing inherent with the number of stations, and the ratchet is limited generally to one-half of the cycle for dwell, the Mercury cam can be designed to have up to two-thirds of the cycle for dwell.

The mechanism will run equally well in either direction. This is a dis-

tinct advantage over the ratchet, where inadvertent reversal of direction most generally causes damage to the machine. Machinery formerly driven by a Geneva mechanism at a rate of 45 indexes per minute, at which pounding began, is now being built successfully with the Mercury cam, and is performing equivalent work at 85 indexes per minute. A highly successful application is shown in *Fig.* 3. This machine makes paper containers and has two turrets and two cams perfectly synchronized to operate at from 67 to 75 indexes per minute. To illustrate the use of this cam in the design of a machine, a hypothetical design problem will be presented, and its solution, encompassing the selection and development of the cam, will be explained.

PROBLEM: It is desired to construct a machine to produce 9-inch diameter containers at the rate of 5000 per hour. There will be eight difference operations performed on the turret which requires eight index stations.

A schematic diagram of this machine is shown in *Fig.* 4. The size of the mandrels and working space between them indicates a 48-inch diameter turret. The desired production rate of 5000 per hour requires 83 indexes per minute. A preliminary design layout is made of the turret and rotating parts on the turret, and a total rotating weight of 675 pounds at an 18-inch radius of gyration is calculated. It is to be pointed out here that selection of a turret of smallest possible diameter and minimum weight is essential for obtaining minimum loads and maximum life of the indexing cam and cam followers.

As mentioned previously, the Mercury cam may be designed with any acceleration curve. Uniform acceleration motion will be used in this analysis. Development work on the cam has shown that 80 degrees of a revolution of the cam for acceleration, 80 degrees of a revolution of the cam for deceleration, and 200 degrees of revolution of the cam at dwell (or fixed position of the turret) has proved satisfactory in practice for a reasonable dwell-to-index ratio. The eight-station turret, as utilized in this example, must rotate 45 degrees per revolution of the cam, of which 22½ degrees is acceleration from rest to maximum velocity, and 22½ degrees is deceleration to rest at the next index position.

Turret Proportions Developed First

First step in design of the cam is to select proportions of the turret driver on which the cam followers are mounted. In some cases the cam followers are mounted directly on the rim of the work turret. This design is most applicable for driving a verticial turret, with a horizontal shaft. However, in the case described, the nature of the work lends itself to the use of a horizontal turret, and a vertical driveshaft. Since it is preferable to have the cam and followers operating in oil, a separate cam follower wheel is employed, located below the turret and on the same shaft as the turret, with the cam followers on a 14-inch mean radius, as shown in *Fig.* 4. The 14-inch radius is determined from the preliminary layout, and must be checked for cam follower loads as discussed later in this article.

Next, the cam diameter and length are calculated.

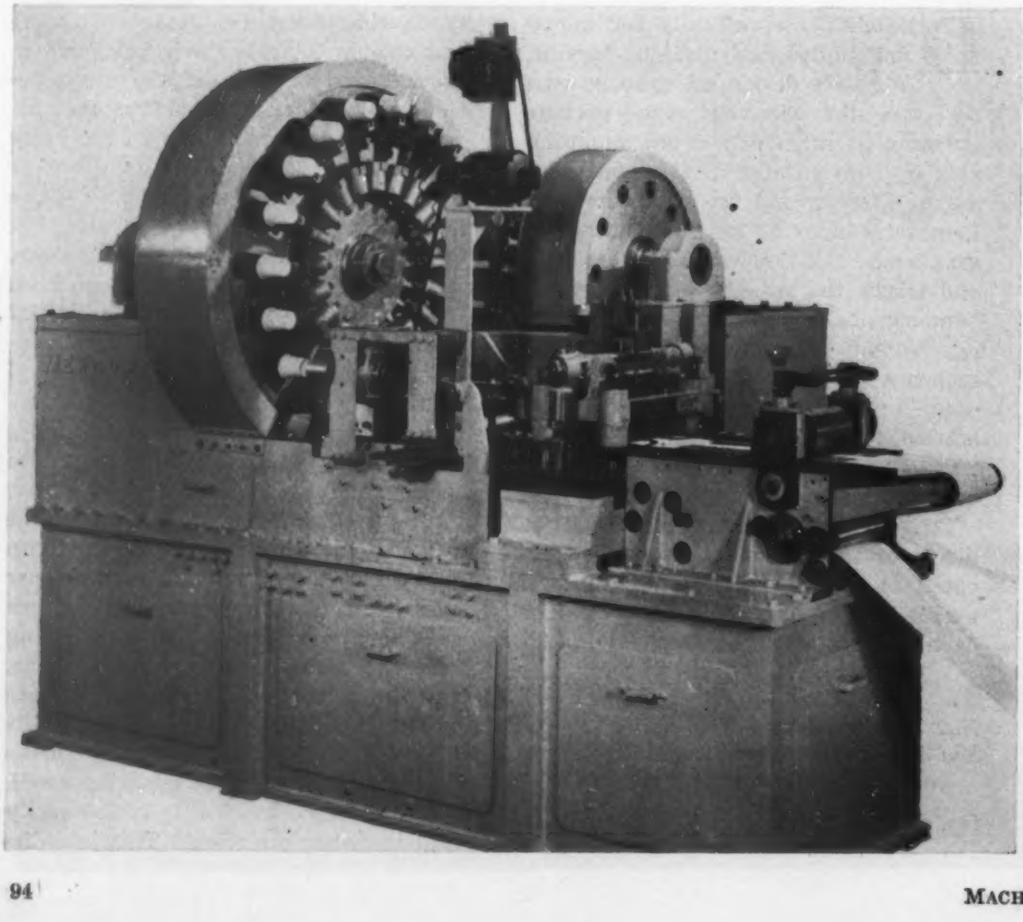


Fig. 3 — Machine for making paper containers employs two turrets and two concave barrel cams; indexes 67 to 75 times per minute

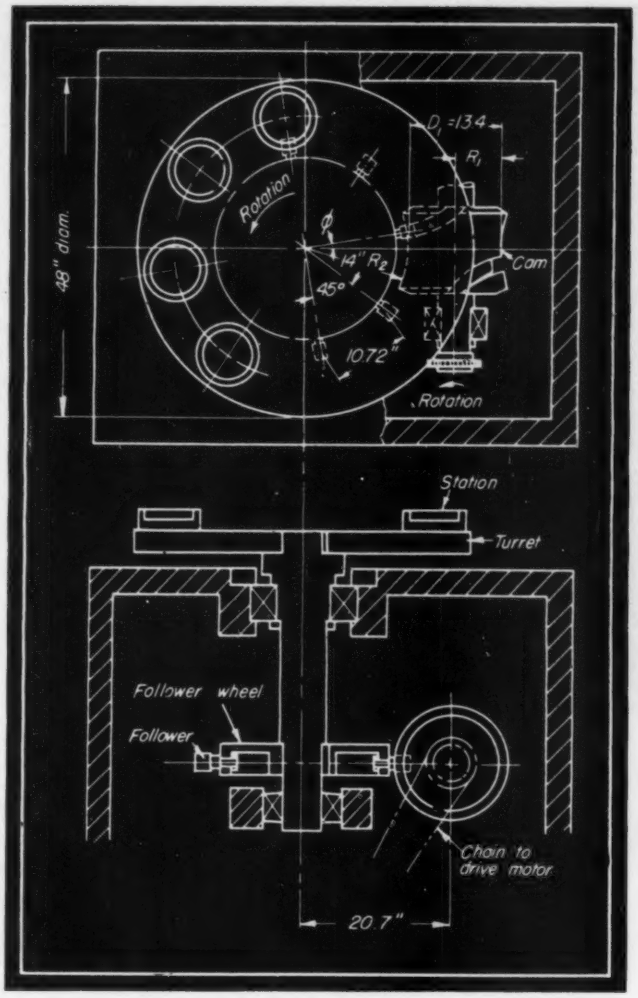


Fig. 4—Schematic of eight-station turret, showing principal dimensions and relationships of follower wheel and cam

The chordal distance the cam follower travels in 45 degrees of rotation of the turret shaft is 2 (sin $22\frac{1}{2}°$) 14 = 10.72. Thus, the overall of the cam face will be approximately 10.72 inches plus the cam lead, or about 11 inches.

Lead Angle Determines Cam Diameter

It has been found in practice that a lead angle on the cam of from 25 to 35 degrees is satisfactory (assuming uniform rise). Selecting 30 degrees as the average lead angle, the next step is to find the center diameter, D, of the cam. Actually the cam is not designed for uniform rise, but this device is convenient for determining D (see *Figs.* 5 and 6).

Now that the basic relationships and dimensions are established it remains to develop the cam track, and check maximum loads on the cam and cam followers. For purposes of charting the cam track, one-half the basic index angle, or $22\frac{1}{2}$ degrees, is divided into increments for a uniform acceleration motion with respect to 80 degrees rotation of the cam. This motion is calculated by converting $22\frac{1}{2}$ degrees into minutes ($22\frac{1}{2} \times 60 = 1350$) and dividing the minutes by 80^2 or $1350/6400 = .2109$ minute. Then as the cam rotation is increased from

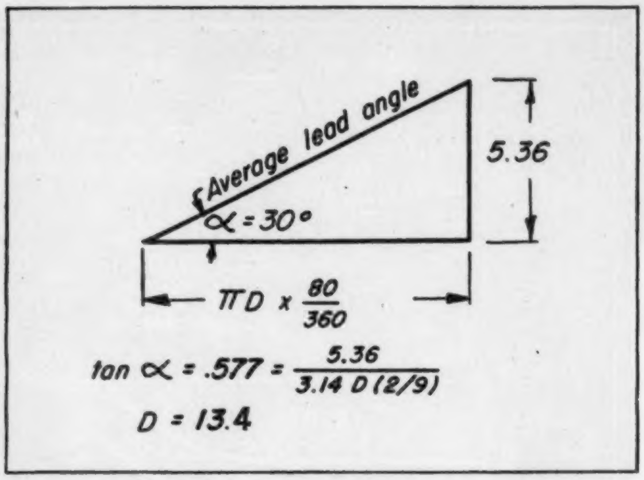


Fig. 5—How center diameter of cam is calculated

0 to 80 degrees, the angle of rotation of the turret, ϕ, will increase in a squared relationship from 0 to $22\frac{1}{2}$ degrees as shown partially in the table:

Cam Angle (α)	Square (α^2)	Turret Rotation (ϕ)
1°	1	0.2′
2°	4	0.8′
3°	9	1.9′
78°	6,084	21° 23′
79°	6,241	21° 56′
80°	6,400	22° 30′
81°	6,559	23° 04′
82°	6,716	23° 37′

In order to have the track enter and run off the cam properly, a few degrees (usually about 6) beyond 80 degrees must be calculated. The difference between the squares must decrease after 80 degrees at the same rate as it had increased before 80 degrees in order to provide the proper motion.

The next step is to find the maximum torque required to accelerate and decelerate the turret in the time interval specified. As noted previously, in this example 83 indexes per minute, or 83 revolutions of the cam per minute, are required. Time in which the turret must index $22\frac{1}{2}$ degrees is (80/360) (60/83) = 0.161 second.

To calculate the torque required in indexing the turret in the required interval, with uniform acceleration from rest to maximum velocity:

$$E = \frac{1}{2}at^2, \text{ or } a = \frac{2E}{t^2}$$

where E = distance in radians, a = acceleration in radians/second², and t = time in seconds. Substituting $t = 0.161$ and $E = 22.5/57.3 = 0.392$, $\alpha = 2 \times (0.392)/0.161^2 = 30.24$ radians/sec².

The moment of inertia, I is

$$I = \frac{1}{2}\,\frac{Wr^2}{g}$$

Substituting values previously given: $I = 0.5$ (675/

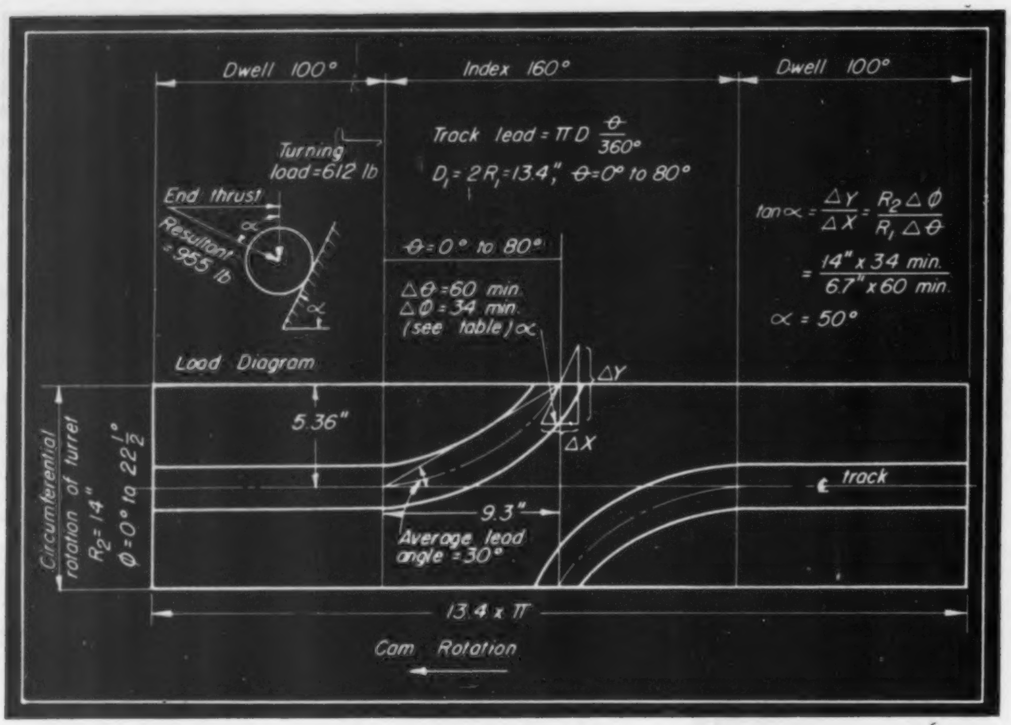


Fig. 6—Cam track development, including load diagram and method of calculating the maximum lead angle

32.2) $(18/12)^2$, or 23.6 lb-ft-sec².

Since torque is the moment of inertia times acceleration,

$$T = I\alpha = 23.6 \times 30.24 = 714 \text{ ft-lb}$$

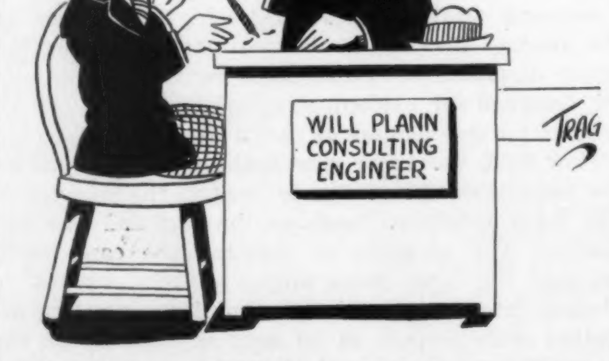
To determine the maximum loads on the cam followers and cam track, a plot of rotation of the turret with respect to rotation of the cam is made, as shown in *Fig.* 6. The maximum resultant load on the follower occurs at the point of inflection of the curve because the lead angle is maximum at this position. Calculation of a 50-degree lead angle at this point is derived as shown in *Fig.* 5, where ΔX is the increment of travel of the cam between 79 and 80-degrees of rotation, and ΔY is the increment of travel of the cam follower during the same period. The rotation of the cam follower during this period is from 21°56′ to 22°30′, (34′) as shown in the table.

During uniform acceleration the torque requirement to rotate the work turret remains a constant, and as calculated previously is 714 ft-lb. With a 14-inch radius cam-follower wheel, the turning load on the follower is $714/(14/12) = 612$ lb. Thus the maximum resultant load on the follower is 612/cos 50 deg, or 955 lb (see load diagram of *Fig.* 6).

A standard 2-inch diameter needle bearing cam follower has a rating of 5150 pounds at 100 rpm. A 2½-inch diameter needle bearing cam follower has a rating of 7650 pounds at 100 rpm. In every instance it is best to choose the largest follower compatible with the rest of the design and the 2½-inch diameter follower will be selected for this problem.

Brinnelling of the cam itself is sometimes experienced, and care should be taken in selection of material for the cam. Successful operation at loads comparable to this typical problem have been obtained by flame hardening the cam track to Rockwell C50 to 55 and polishing the track after hardening.

In low production work, where one or two of a particular cam is required, SAE 4140 forged steel billets provide a good material. In larger quantities, a fine-grain alloy steel casting may be employed, with the track premachined undersize on the pattern. The method of producing cams by casting and cutting the track on a track milling machine has made the cam extremely favorable costwise.



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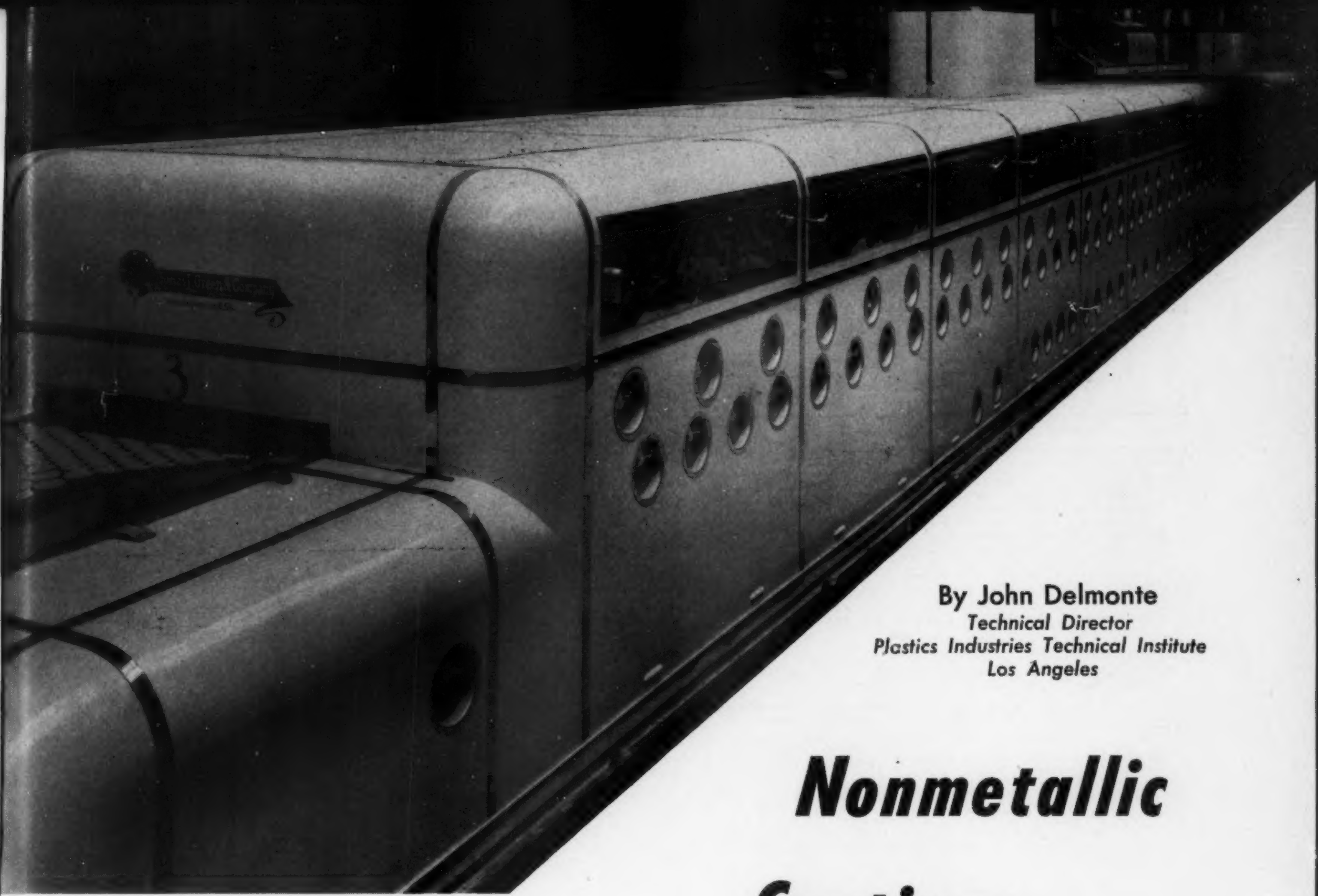


By John Delmonte
Technical Director
Plastics Industries Technical Institute
Los Angeles

Nonmetallic Coatings

. . . engineering characteristics of protective coatings

SURFACE coatings may be successfully engineered to fulfill various functions pertaining to machine design. While many designers overlook these possibilities by briefly specifying exterior color, a more considered analysis of the engineering characteristics possessed by coatings may reveal useful possibilities.

Nonmetallic coatings are either organic plastic materials or inorganic compounds fused into porcelain-like finishes, *Fig.* 1. The former category is the most popular because it is the easiest to apply and the most versatile, though the high temperature-resistant characteristics of the latter are very important. One of the fundamental properties of high molecular weight (polymerized or partially polymerized) plastic materials is their ability to form a thin continuous film when applied from a solvent or liquid vehicle. The characteristics of this film reflect the qualities of the plastic from which it was prepared, though naturally there are new considerations of porosity and adhesion introduced by thin films. However, resistance of organic coatings to chemicals, to weathering, discoloration, abrasion, or in general, the relative permanence of its qualities may be anticipated from an understanding of its properties as a plastic.

Fig. 1—Above—Porcelain enamled oven built by Thomas L. Green & Co. Abrasion and heat resistance of this sanitary white finish make it particularly suitable for use in the baking as well as other food processing industries

As an aid to understanding the engineering characteristics of nonmetallic coatings, general methods of classification are very helpful. These coatings may be classified by the volatiles that are present and by the method of film formation. TABLE I contains a classification of this nature, together with a few comments on significant industrial applications.

AIR DRYING LACQUERS: There are other methods of describing coatings besides the classification appearing in TABLE I. These include a classification based upon the chemical nature of the film and the

temperature required to aid film formation. Thus, for example, there are air drying lacquers which form their films upon the simple evaporation of solvents. Included in this group are polymers of cellulose esters, synthetic resins and natural resins. When a machine component does not lend itself to baking operations the air drying lacquers are invaluable. Their smoothness and appearance will depend to a large extent upon the surface to which they are applied, smooth surfaces giving better finishes.

ENAMELS: Usually of the oven baked variety, enamels are based upon pigmented oleoresinous varnishes. These oil-synthetic thermosetting resin combinations form their films by oxidation and polymerization reactions. They are heat and solvent resistant and are widely used on metal parts, *Fig. 2.* Much of the success of the coating depends, however, on the care exercised in preparing the surface.

TABLE I

Classifications of Nonmetallic Coatings

Chemical Nature of Coating Materials	Method of Film Formation	Typical Applications
Lacquers—Volatile Solvent Major Constituent (75-85%)		
Cellulose nitrate. Special degree of nitration and low viscosity ratings. Modified with natural gums, resins and plasticizers	On evaporation of solvents. Air drying	Most important and widely used lacquer. Formulations for wood, metals, paper, cloth, etc.
Polyvinyl chloride copolymer lacquers. Flexible grades with plasticizers	On evaporation of solvents. Slow drying	Metal and concrete coatings, where maximum chemical resistance is required
Shellac, dissolved in alcohol	On evaporation of solvent	Insulating coating, wood sealer and coating
Mixed asphalts dissolved in aromatic solvents	On evaporation of solvent. Baking required for force drying of larger masses	Impregnation of wound motor and transformer coils
Chlorinated rubber, silicones, polystyrene, polyvinyl alcohol, acrylics, and most soluble thermoplastics	Solvent evaporation. Rate depends on solvents	Miscellaneous purposes
Aqueous Dispersions—Fine Colloidal Organic Polymers. Typical Water Content 40-50%		
Oil-alkyd resin dispersions, including pigments, detergents, protective colloids	Absorption and evaporation of water, then oxidation of film	Interior coatings. Best on plaster board, wood or paper
Polyvinyl chloride, polyvinylidene chloride, copolymers in latex form; and also colloidally dispersed plasticizers	Absorption and evaporation of water. Film continuity aided by flash heating	Cloth and paper coatings. Development work in progress on metal coatings
Natural and synthetic rubber latices, stabilizers and vulcanizing agents	Absorption and evaporation of water, and heat to vulcanize rubber stocks. Thick films developed by electrodeposition	Numerous mechanical rubber goods, thick flexible coatings possible for metals. Coated textiles, such as waterproofed fabrics
Aqueous Dispersions of Inorganic Compounds Water Content Variable		
Portland cement—$Ca(OH)_2$—metallic soaps	Hydration of Portland cement	Concrete coating—sealer and waterproofing aid
Soluble sodium silicates and china clay fillers	Absorption and evaporation of water	Concrete sealer, though poor water resistance. Best as corrugated paper adhesive
Casein—pigments—slaked lime—alkaline salts	Absorption of water into porous structure. Reaction between casein and $Ca(OH)_2$	Basis of low cost whitewash paints for concrete and wood
Inorganic frits—Feldspar, SiO_2, Kaolin, dispersed in water	Evaporation of water and by high temperature fusion and vitrification of the silicate	Porcelain enamel-like finishes for metal and ceramic products. Outstanding scratch resistance, weathering, and temperature resistance
Oleo-Resinous Varnishes. Minor amount of Volatiles		
Drying oil—alkyd resin—pigments, oil and resin compatibility. Modifications through combinations with cellulose nitrate, chlorinated rubber (speeds drying); "EPON" resins (alkali resistance); styrenated oils (electrical properties)	Oxidation and polymerization by oven baking	Base of many well known pigmented enamels widely applied to metal and wood products
Oil modified phenolic resins. Rosin modified phenolics, 100% phenolics, and drying oils	Oxidation and polymerization accelerated by oven baking	Important wood and metal industrial enamels. Hard and weather resistant finishes such as "spar" varnishes
Oil modified, butylated urea and melamine resins	Oxidation and polymerization by oven baking	Light colored, hard, scratch resistant enamels for stoves and refrigerators
Oil Base Paints—Minor Amount of Thinner		
Drying oils—linseed, soya bean, dehydrated castor, perilla, tung plus pigments, red lead, barium sulfates, zinc oxide, lead chromate, titanium dioxide, calcium carbonate, etc., and metallic driers	Oxidation of oils, slow drying	Base for most exterior household paints for wood and stucco. Low cost. Some drying oils used as transformer potting compounds
100% Resinous Coatings—No Volatiles		
Thermosetting phenolic and furane resin coatings and catalyst	Polymerization of resin	Hard, chemical resistant coatings for wood, concrete and tank linings
Plasticizer — thermoplastic hot melts (ethyl-cellulose, cellulose acetate-butyrate)	On cooling of hot melts	Thick protective coatings of metal parts for shipment. Electroplating racks
Asphaltic compounds	On cooling of hot melts	Extensively used for building up thick coating deposits and providing adhesive bonds for sound insulating materials
Fusible thermoplastics such as polyethylenes and polyamides	Sprayed from gun, melted in flame—uneven film	Still in development—where properties of the plastic might prove valuable
Vinyl resin "plastisols"	Gelation of coatings upon heating	Thick rubber-like deposits for chemical resistance

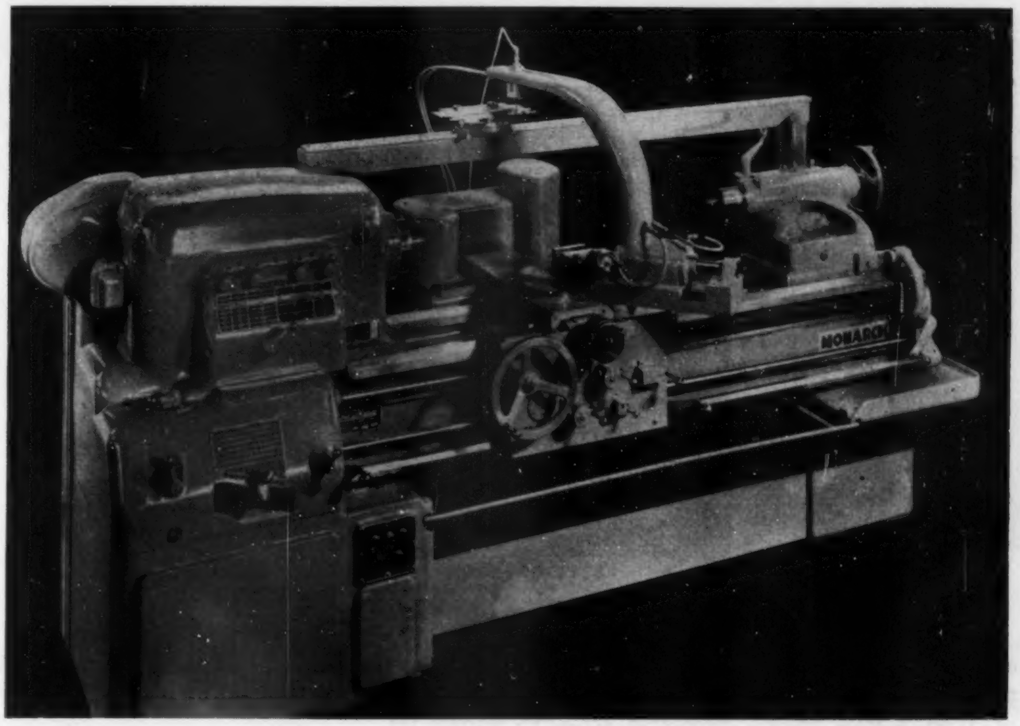


Fig. 2 — Oil-resistant enamel on Monarch lathe retains its appearance and protective qualities in shop surroundings

Fig. 3—Below—Effect of thickness on dielectric strength of plastic coatings

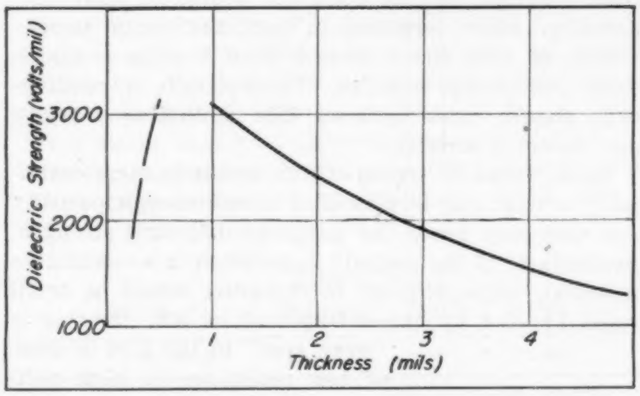
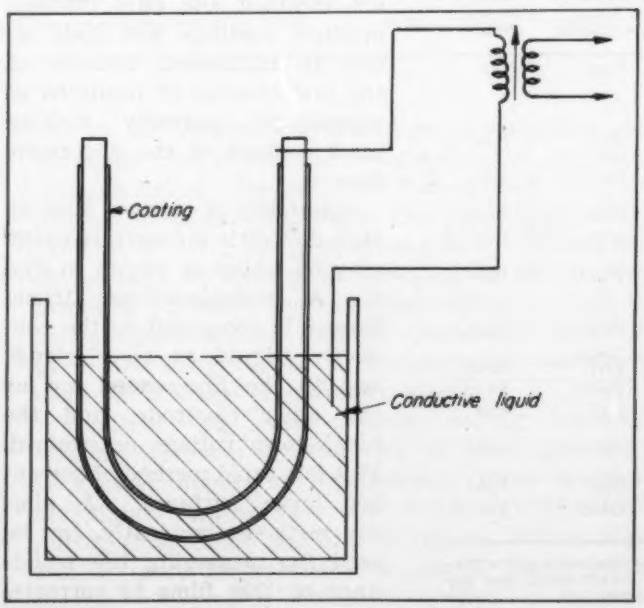


Fig. 4—Below—Simple test for determining dielectric strength of a coating by measuring breakdown voltage



Treatments for preparing metal surfaces for nonmetallic coatings include:

Removal of loose and foreign matter

1. Wire brushing
2. Sand blasting
3. Flame cleaning for structural steel
4. Pickling or etching of surfaces
5. Solvent degreasing
6. Alkali washes.

Chemical Pretreatments*

1. Phosphatizing—developments such as Parkerizing and Bonderizing to form an adherent phosphate coating on steel
2. Anodizing of aluminum—adherent aluminum oxide film
3. Chromatizing of magnesium and aluminum parts.

Chemical pretreatment insures a firm and adherent undercoating for subsequent nonmetallic coatings. Improved performance and durability can be expected. Phosphate coatings on steel surfaces have an outstanding commercial record in their application to automobile bodies.

Characteristics of Coatings

Further distinctions are made on the basis of specific applications on materials such as wood, metal, cloth or paper coatings. However, data contained in TABLE I are sufficiently complete to permit such selections to be made. In the following paragraphs the characteristics of nonmetallic coatings are evaluated in the light of their design expediency.

DIELECTRIC PROPERTIES: Most organic plastics are capable of forming good insulating coatings where high dielectric strength and high electrical resistivity

* Chemical pretreatments are discussed by Joseph Mazia—"Protective Coatings", MACHINE DESIGN, Jan., 1949, Page 110.

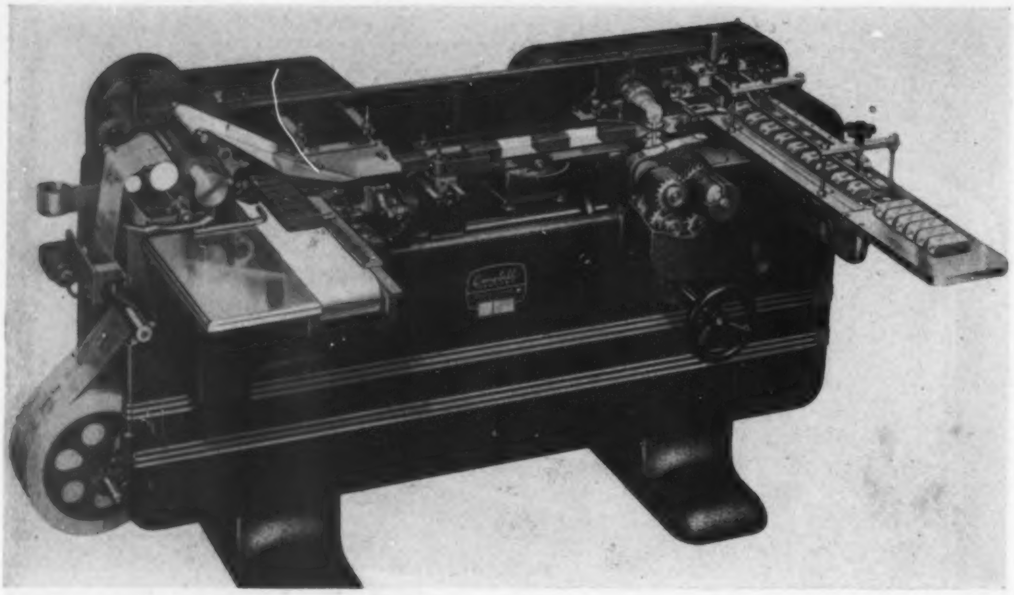


Fig. 5—Wrinkle finish on Campbell wrapping machine. This easily applied, practical coating has excelent eye appeal as well as unusual wearing and covering qualities

are of paramount importance. At the film thicknesses usually formed by the coatings (of the order of 1 to 3 mils thick) dielectric strength shows its greatest variation. The dielectric strength, expressed as volts per mil of thickness, will vary with thickness, as shown in *Fig.* 3. These data must be well understood if dielectric strength properties of the coatings are to be utilized in the design. Ordinarily, close control of film thickness is not exercised or not necessary, though the solids content of the coating composition as well as method and time of application will determine this factor.

There are mitigating circumstances which will alter the nominal thickness of the coating. Surfaces other than perfectly flat will have a gradation of film thickness and a thinning out at sharp corners and projections. Obviously dielectric strength and total breakdown voltage should be predicated on the thinnest coating. There are less obvious variables which may be even more serious. The evaporation of solvents from coatings creates a certain degree of molecular porosity, which explains in part the vapor permeability of thin films formed from coating compositions containing volatiles. Theoretically a relationship should exist between this molecular porosity and dielectric strength.

Small, invisible traces of dirt and inclusions contribute to what may be classified as microscopic porosity and this may lower the apparent dielectric strength, particularly if the particle in question is a conductive material. More difficult to recognize would be small voids created by the entrapment of air, creating a "weak spot" in the film because of low resistance to high voltage stresses. These same defects are frequently present in mocroscopic proportions, visible to the eye. Bubble inclusions are common and only through multiple coatings will their effect be minimized, because of the low chances of positions of microscopic porosity making joint contact in the successive films.

Suitability of organic films as high dielectric strength coatings may be tested as shown in *Fig.* 4. A variable-voltage transformer is connected to the conductive liquid as an electrode and to the film-coated rod as the other electrode, and the break-down voltage determined. This is a rapid method of screening large surfaces. A similar methods, incidently, can be used for measuring the resistance of thin films to corrosive

TABLE II
Behavior of Typical Thermoplastic, Elastomeric and Thermosetting Film Coatings

Material	Dielectric Strengths of Films (0.001–0.002")	Metal Adhesion	Flexibility	How Flexibility Is Achieved*	Resistance to Aging, Weathering	Resistance to Alkalies, Acids
Cellulose esters (Cellulose nitrate, acetate, acetate-butyrate)	1000–2000	Good	Fair	Through soluble plasticizers	Poor	Poor
Ethylcellulose	1500–2500	Fair	Fair	Through soluble plasticizers	Poor	Poor
Polyvinyl acetals	1500–2000	Good	Good	Chemical structure and plasticization	Fair	Fair
Polystyrene	2000–3000	Poor	Poor		Poor	Good
Polymethyl methacrylate	1500–2000	Poor	Fair		Good	Fair
Polyisobutylene—polystyrene copolymer	2000–3000	Good	Good	Chemical structure	Fair	Good
Polyvinyl chloride copolymers	1000–2000	Poor	Good	Through soluble plasticizers	Fair	Good
Polyethylene	2000–3000	Poor	Good	Chemical structure	Fair	Good
Natural rubber	1000–2000	Good	Good	Chemical structure	Poor	Fair
Polychloroprene (Neoprene)	500–2000	Fair	Good	Chemical structure	Fair	Fair
Butadiene-acrylonitrile copolymer	500–2000	Fair	Good	Chemical structure	Fair	Good
Chlorinated rubber	1000–2000	Good	Fair	Plasticization	Poor	Good
Oil-modified phenolics	1000–2000	Good	Fair	Plasticizing effect of drying oils	Good	Fair

* Those polymers owing flexibility and elongation to chemical structures are inherently more flexible than those polymers depending on plasticization. In view of plasticizer volatilization and migration, the former may be considered more permanently flexible in thin film form.

Fig. 6—Siliconed exhaust pipe for Harley-Davidson motorcycle. Three coats are air dryed and then baked to provide heat and corrosion resistant finish

influences. In this type of test, a large number of coated specimens are prepared and placed into the corrosive medium. At various intervals samples are withdrawn and the dielectric strength ascertained. The relationship between dielectric strength and time shows the progress of corrosion.

To realize full dielectric advantages of organic films, the designer must select films which will adhere satisfactorily to the surfaces to be protected. This means that good adhesion must prevail under all conditions of service and during the life of the part. High initial adhesion and flexibility, which may be

TABLE III

Methods for Obtaining Thick Coatings

Materials	Techniques
Hot melt—ethylcellulose or polyvinyl chlorides	Bring to molten condition, immerse article. Coating forms on cooling
Vinyl resin dispersions (plastisols)	Warm articles and apply vinyls which will gel on being heated
Cellulose acetate butyrate gel lacquers	Special lacquers which gel at room temperature
Electrolytic deposit from rubber latices	Rubber deposits at anode

due to the retention of traces of solvent that plasticize the film, should not be mistaken for permanent characteristics. Instead the film should be force dried if necessary, to remove the volatiles which are present. If after aging the film can be removed only by pulling, scratching or scraping it off in small pieces, it probably has sufficient adhesion. Such empirical tests should also be performed after the parts are subjected to a representative amount of mechanical abuse or corrosive attack.

Flexibility to resist fracture during functional bending, abrasion, or assembly of the coated parts is another important requirement. Many otherwise acceptable coatings are not suitable mechanically during their functional life. A typical coating which fulfills these requirements is one of the polyvinyl acetals (Formvar), which is applied to magnetic wires. These coated wires may be twisted into a knot and pulled tight without breaking the coating. It takes only one small crack to make valueless a good dielectric coating, and for this reason, proper material selection as well as design safeguards are necessary.

To obtain the advantages of organic films as dielectric coatings, the designer must:

1. Anticipate the presence of high spots and burred edges on the surfaces of metal parts being coated
2. Specify multiple coatings with a minimum of dirt particles or air bubbles
3. Select coatings with high dielectric strength, good specific adhesion to the conductive surface and sufficient flexibility to resist fracture during functional bending, abrasion, or assembly of the coated parts.

Thermoplastic films possess the necessary flexibility, high dielectric strength, and resistance to aging to fulfill most requirements. The comparison in TABLE II should assist the designer in specifying an acceptable coating. Thermoplastic films are generally prepared from solvent type lacquers or aqueous dispersions, depending on solvent evaporation for film formation. Generally thermosetting films require baking to harden, are more age resistant, and are less flexible.

THICK, RUBBER-LIKE DEPOSITS: The deposition of relatively thick rubber-like coatings on metal surfaces offers several characteristics which may be effectively utilized as design expedients. The materials which may be deposited as thick coatings in one application are relatively limited and usually of special formulation. Ordinary lacquers and oleoresinous varnishes cannot form thick coatings, unless by multiple sprays and dips. Various methods for depositing thick, flexible coatings over $^1/_{32}$-inch in one operation are shown in TABLE III.

In the following paragraphs are outlined a number of representative applications where thick, flexible coatings may be of definite advantage.

Surface defects and porosity of castings are mini-

mized: Thicker coating deposits of the order of $^1/_{32}$-inch and greater will more effectively cover up surface defects than thin coatings of 1 or 2 mils thick. Nonrubber-like wrinkle finishes, *Fig.* 5, are also effective in achieving this function.

Friction grips: A thick, rubber-like coating on hand grips for portable machine tools will give greater assurance to the operator in handling the parts. Perspiring hands and slick metal surfaces are uncertain combinations. A further advantage accruing from thick coatings is the reduction of heat transfer and the greater comfort and ease of handling to the operator. Also, the coating will serve as a good dielectric insulator and reduce electric shock hazards.

Vibration and noise absorbers: The absorption of vibration and noise by rubber-like coatings represents an important attribute. While not a replacement for sheet rubber gaskets and cushions between vibrating and stationary machine components, thick rubber-like coatings will reduce the noise level at the same time that dirt and corrosion protection is achieved. A practical example of these benefits is

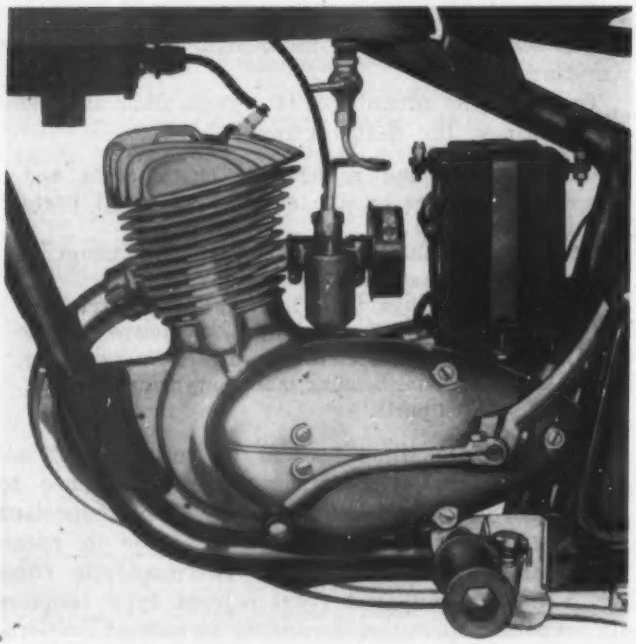


Fig. 7—Cylinder head on motorcycle engine has two baked coats of silver-colored silicone to give pleasing appearance and to resist corrosive effects of moisture and high temperature. Photo, courtesy of Harley-Davidson Motor Co.

the underseal coating being applied to the bottom side of automobiles. These coatings have been applied to thousands of cars and have satisfactorily held up to expectations.

HIGH OPERATING TEMPERATURES: The porcelain-like, nonmetallic coatings have made remarkable advances in recent years, and in machine design entailing high-temperature operation they will greatly extend the resistance of simple steels to excessive corrosion. There have been many successful examples of porcelain enamelled refrigerators and ovens, and their resistance to scratching and abrasion are well known. Machine components subject to sharp thermal gradients present problems due to the thermal differences between the metal core and the porcelain surface. However, the experience and background gained by porcelain enamelers will do much to extend this type of coating into machine design.

Making enamel adhere tc metal is not always an easy job, and often special steels are required. The steels should be carefully cleaned and prepared. Cobalt and nickel oxides added to the frits will promote adhesion to steel. The dark color of these enamels, however, is objectionable for some applications and a light colored enamel, pigmented by zirconium or titanium dioxide may be added. Porcelain enamels are usually fired at temperatures of 1500 to 1600 F.

Among recent applications, porcelain enameled chutes speed conveying operations, as materials will slide down readily on their surfaces. Efforts are being made to reduce coating thickness and firing temperatures as the thick, bulky coatings crack too readily. Some success has been achieved with one-coat products with a total thickness in the vicinity of 3 mils. These have offered a high degree of flexibility and outstanding corrosion resistance.

Not all metal parts may be conveniently fired to reap the advantages of high-temperature porcelain enamels. Small intricate castings and forgings, larger pieces which cannot be handled by the firing ovens represent parts not readily handled in porcelain enameling. For these problems, the next available coatings are those prepared with a silicone resin base. For example, silicone varnishes with aluminum pigments have been used successfully on exhaust pipes, *Fig.* 6, mufflers, engines, *Fig.* 7, and ovens. Tests indicate that these coatings are suitable for temperatures of 500 F. Nonyellowing and nonchalking grades of silicone resin coatings are available. In coating steel with these resins, a "Bonderizing" or "Parkerizing" pretreatment of the steel surface is recommended for maximum adhesion. For lower temperatures of operation, alkyd, phenolic and urea varnishes are acceptable. Thus, the operating temperature limits would be as follows:

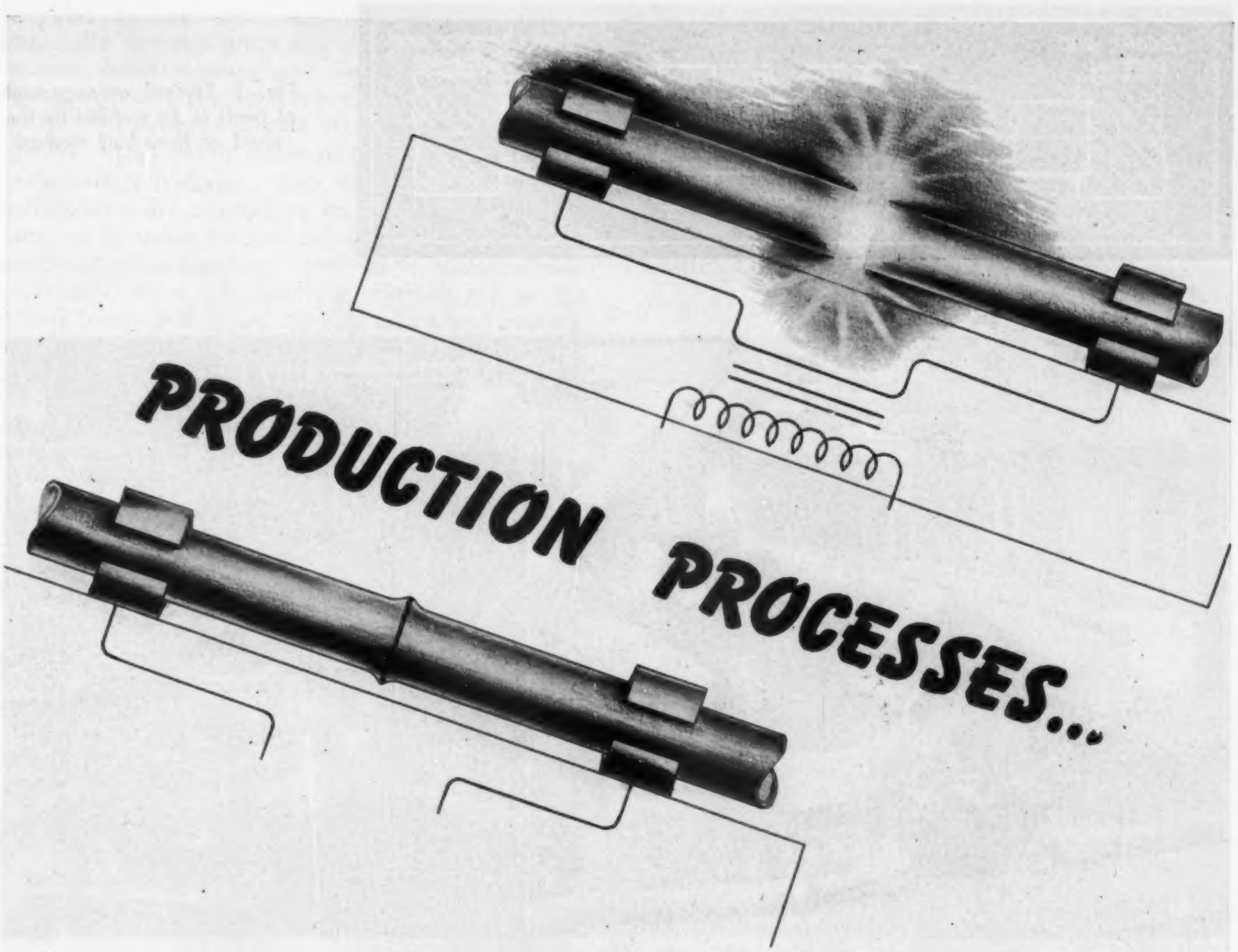
Coating	Operating Temperatures
Porcelain enamel	1000 F
Silicone—aluminum pigment	500 F
Phenolic, urea and alkyd	250 F

COLOR REQUIREMENTS: Best known and among the oldest functions of nonmetallic coatings upon machine parts are the color requirements. If for no other reason than sales appeal and cleanliness, the value of decorative coatings has been acknowledged. To the wide range of color may be added many specialty coatings such as wrinkle coatings, crystalline coatings, hammer-tone finishes, metallic lusters, pearlessence finishes, flock finishes, wood and special grain effects through decalcomania, and a score of others. These developments bear witness to the demand for decorative and novelty finishes.

CORROSION, CHEMICAL AND MOISTURE PROTECTION: The greatest value of most nonmetallic coatings is

(*Concluded on Page* 162)

PRODUCTION PROCESSES...



Their Influence On Design

By Roger W. Bolz
Associate Editor, Machine Design

Part XLI—Butt Welding

FOURTH and last in the series of articles on resistance welding processes is butt welding. Consisting primarily of welding end-to-end or abutting pieces of metal, butt welding differs from spot, seam and projection welding in the fundamental procedure utilized to obtain the heat required for welding. Parts are clamped in current-carrying dies, one of which is powered to bring the two pieces together. By either joint resistance or arcing and flashing, the ends of the parts are brought to a temperature within the plastic range of the metal, allowing pressure from the moving die to upset and forge the parts into a single unit, *Fig.* 1.

Butt welding permits the welding together of rods, bars, sheets, tubes, stampings, forgings,

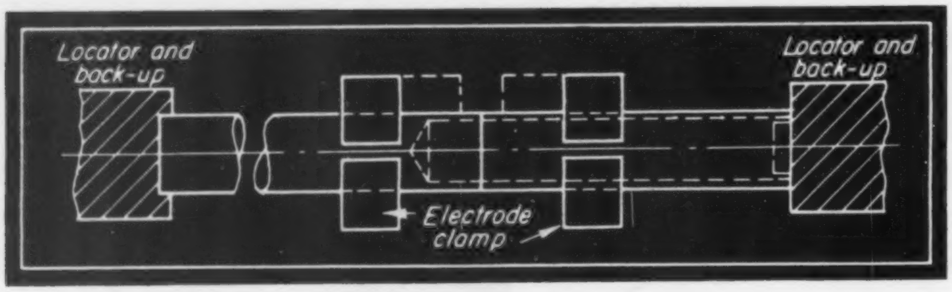
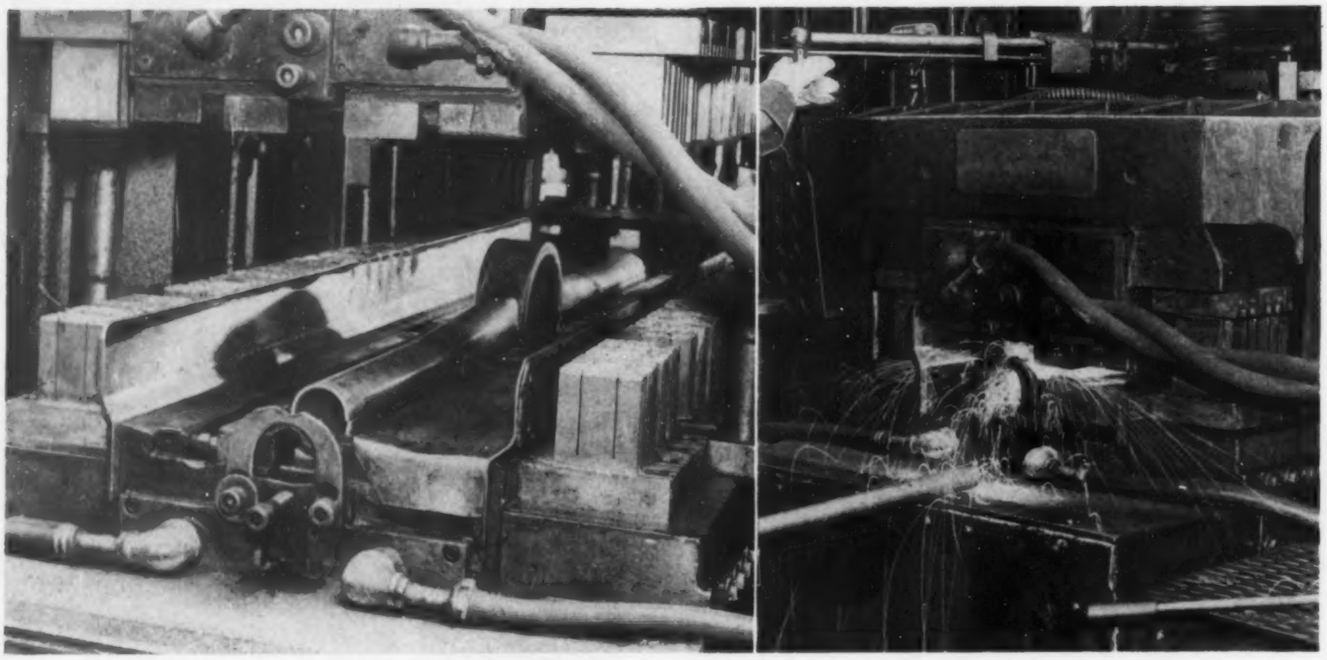


Fig. 1—Typical arrangement of parts to be welded by the upset or flash-butt method



channels, angles, and an almost limitless variety of complex parts so designed as to allow satisfactory handling by this method. Practically all the metals capable of being spot, seam or projection welded can be readily butt welded. Unlike these other methods, however, welding occurs simultaneously over the entire area of contact providing an extremely uniform, homogeneous joint having a strength factor approximately equal to that of the parent metal itself. The uniform heating and cooling throughout the weld zone minimizes trapped, localized stresses and the operation is completed with such speed that portions beyond the weld zone are not heated sufficiently to cause warpage, scaling or heat oxidation. As with the other resistance methods, no metal is added and chemical composition remains virtually unchanged. Material losses due to upsetting action are small.

Fig. 2 — Above — Formed and drawn automotive rear axle halves showing welder loaded and in the flashing operation

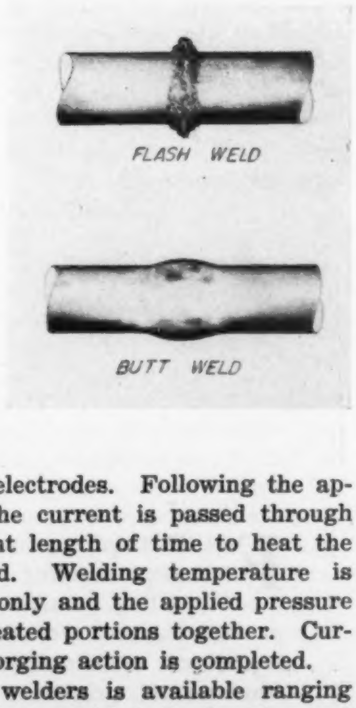


Fig. 3 — Right—Typical flash-butt and upset-butt welds

Flash Welding Most Versatile

WELDING METHODS: Butt welding is normally subdivided into two major classes: (1) Upset-butt welding, and (2) flash-butt welding. While flash-butt welding is probably the most versatile and widely used, each method has specific attributes which afford a wide overall range of application.

Upset-Butt Welders: With upset welders the full upset pressure is first applied to the work to be joined after clamping in the electrodes. Following the application of pressure the current is passed through the part for a sufficient length of time to heat the portions to be welded. Welding temperature is achieved by resistance only and the applied pressure upsets or forges the heated portions together. Current is cut off as the forging action is completed.

A variety of upset welders is available ranging from hand-operated units in which both clamping and upsetting is hand actuated, to mass-production machines in which current application and upsetting action are fully automatic. Upsetting force may be

provided by pneumatic or hydraulic power or mechanically through gears and cams. For upset-butt welding small sections and copper wire or rod, a spring operated pushup mechanism is often used for quick and automatic forging pressure. In some cases pressure is applied by means of weights and levers.

Flash-Butt Welders: With flash welders the parts to be joined are clamped in the electrodes much the same as in upset welders but with the ends of the parts not quite touching. Current is applied simultaneously with a low upsetting pressure and as the metals touch, arcing and flashing take place creating considerably greater heat than by contact resistance only. As the flashing continues, vapor explosions expel slag and other impurities and finally when the metal has reached a welding temperature the upsetting pressure is suddenly increased, extinguishing the arc and forging the pieces into a strong weld.

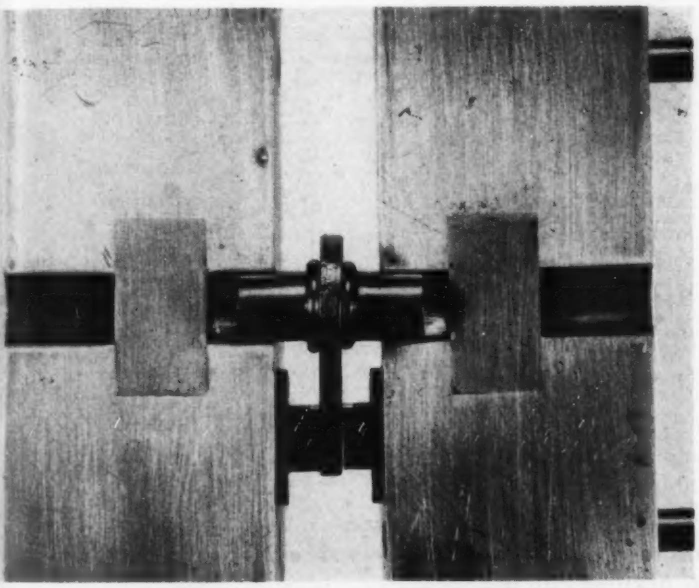


Fig. 4 — Upset welder dies showing a flat blanked part riveted to bar by means of electric upsetting on each side of a hole

Flash welders follow closely the styles available in upset welders, in fact both classes of welds may be made on the same machine by changing the method of operation. While manually operated machines are available they are limited to small cross sections and general work, automatic power-operated machines being preferable for production runs and more consistent quality. Spring, gear and cam, pneumatic, or hydraulic drives are normally provided as with upset machines. The standard range of machine capacities

TABLE I
Specifications for Standard Butt Welders

Upset Butt Welders

Size No.	Rating (kva)	Upset Pressure (lb, max.)	Platen Opening (in.)	Platen Size (width x length, in.)
000	2	12	1/12	1 x 1⅝
00	5	70	½	1⅛ x 3
0	10	120	⅝	1¾ x 4

Flash-Butt Welders

Size No.	Rating (kva)	Upset Pressure (lb, max.)	Platen Opening (in.)	Platen Size (width x length, in.)
1	20	2,250	2	12 x 12
2	50	4,500	2½	16 x 16
3	100	11,500	3	20 x 20
4	150	19,600	4	24 x 24
5	250	38,000	5	28 x 28

as set up by the Resistance Welder Manufacturers Association is listed in TABLE I. Special machines of a much wider range in capacity, however, have been manufactured and are extensively used, *Fig.* 2.

Range of Application: The primary advantage of flash over upset welders is their lower current demand. Where large areas are to be welded, the upset method is apt to require excessive amounts of current. As a consequence, upset welding is utilized primarily for welding small and medium-size cross sections whereas the flash method permits the joining of section areas of 80 or more square inches in

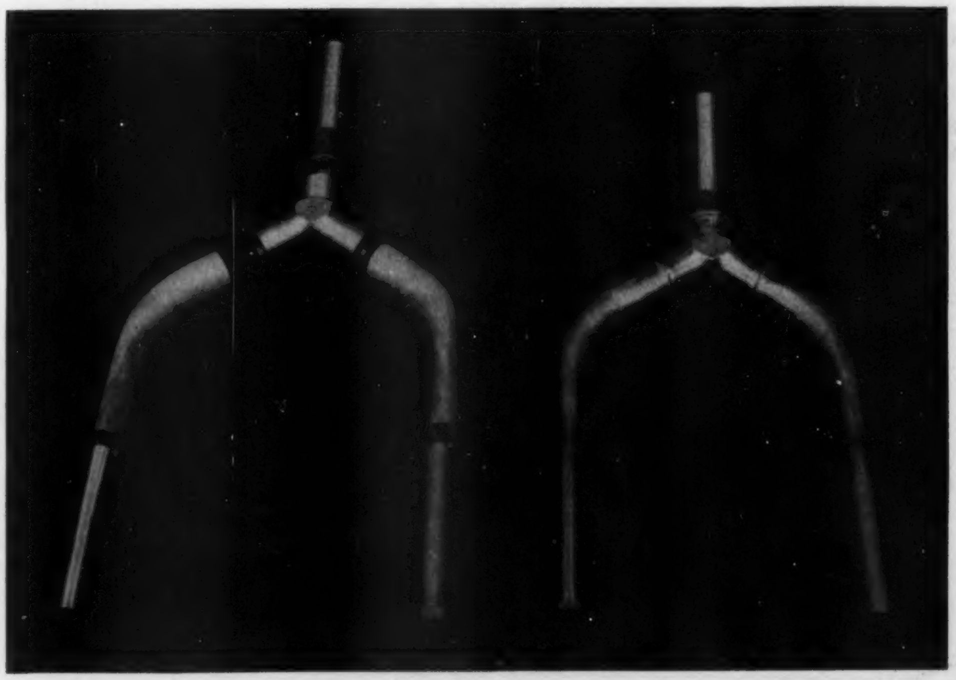


Fig. 5 — Right — Aircraft link assembly unit comprised of shaped bar, formed tubes, machined forgings, and turned barstock. Welding flash is readily visible on completed assembly

low-carbon steel. Flash-butt welding, however, is extremely versatile and need not be confined to large sections. Areas as small as 0.0015 square inches can be welded and machine capacities may range from ⅛-kva on up. Wire as small as 0.004-inch in diameter has been upset-butt welded in production.

Selection Between Methods

Although either process may be optional on certain designs, such is not generally the case and actually there is no clear line of demarcation between the two methods. In some instances the material may determine whether an upset or a flash-butt weld is to be used; again it may be the design of the particular pieces to be welded.

The upset-butt weld is primarily adapted for welding ferrous materials which can be joined at temperatures below the melting point. Where the flash spatter and ragged upset characteristic of flash welding is undesirable or impractical to remove, the upset-butt weld often proves more satisfactory, although the upset is usually greater, *Fig.* 3. The flash method, however, is satisfactory for welding many nonferrous metals and alloys not possible to handle by means of the upset-butt method. If complete removal of the excess metal is necessary, it is generally much less expensive and less difficult to remove the flash from a flash weld than it is to form an equivalent upset weld.

Percussive Welders: Also confined to the production of butt-welded joints, percussive welding is a rather specialized method principally used for butt welding small-diameter wires. With these machines, an intense electrical discharge occurs simultaneously or just prior to the application of pressure to the parts in the form of a hammer blow. Heating is accomplished by the playing of the arc across the metal faces, resistance of the metal being of little consequence. Because of this, materials impossible to weld by upset or flash methods, such as copper to stainless for instance, can be readily welded. Fusion being confined to the surface of the parts, results in little or no flash. Areas to be welded must be concentrated as in round or square sections, thin or wide faces being impractical. Total area must not be greater than ½ square inch but most applications are mainly with wire parts under ⅛-inch in diameter.

Electric Upsetting: As mentioned in the article covering hot upsetting operations in this series, the upset-butt welder can be used to produce gathers or upsets on bar stock, much like the electric gathering machine. Electric upsetting to increase the stock diameter at specific points can be applied to low-carbon steel, aluminum, stainless steels, bronze, brass, Monel, and like materials. Size of upset or volume of gather is dependent upon the die movement of the machine. By proper control of the current, location of the workpiece, selection of the die materials for conductivity, etc., uniform annular upsets, eccentric upsets, multiple upsets, spherical or narrow upsets can be produced. Special shapes may be obtained by the use of special dies designed to confine the material to the desired contour during upsetting. Electric riveting can also be done and in many instances upsets can be employed for fastening parts to rod or tubing economically, *Fig.* 4.

TABLE II
Common Ranges of Flash and Upset Welding Pressures

Material	Thickness (in.)	Pressure (psi)
Aluminum		
Soft alloys	Up to ⅝	4500 to 5500
High strength alloys		to 20,000
Copper		
Plain	Up to ¾	5000 to 7500
Steels		
AISI C1020	Up to ⅜	6000 to 8000
AISI C1020	⅜ to 1	7000 to 10,000
AISI C1020	1 to 2	9000 to 11,000
AISI C1020	2 to 4	10,000 to 12,000
AISI 2340	Up to 1	10,000 to 12,000
AISI 3140	Up to 1	10,000 to 12,000
AISI 4140	Up to 1¼	11,000 to 18,000
AISI 6145	Up to 1¼	11,000 to 18,000
Stainless alloys	Up to 2	13,000 to 25,000
High-temperature alloys		to 35,000

DESIGN: Owing to the wide range of application afforded by butt welding methods, an unusual degree of flexibility in design is made possible. Fabrication of tubular parts, combination tubular and solid fittings, combination sections, and composite parts made up of stampings, castings and forgings or arrangements of several in similar as well as dissimilar metals is readily accomplished by these methods, *Fig.* 5. Also possible are combinations of electric upsetting and butt welding to complete a part, *Fig.* 6. Utilization of butt welding to obtain forged assemblies too

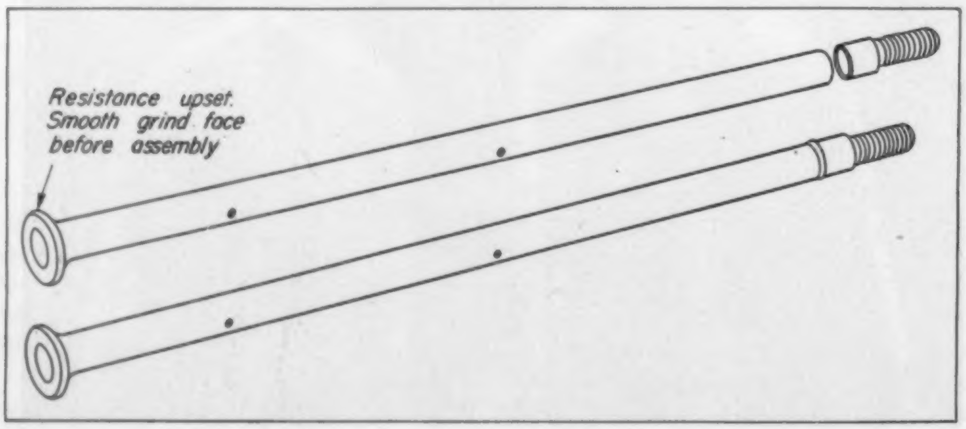


Fig. 6—Left—Flash welded tubular aircraft strut on which the end is electric upset to form a flange

complex as a unit but with individual parts well within the practical range, is also an excellent means for cost reduction, *Fig.* 7.

Upset-Butt Welding: As previously noted, the upset-butt method is primarily confined to the welding of small to medium sections in ferrous materials. Owing to greater accuracy necessary in preparing upset-butt welded surfaces to assure equalized contact resistance, greater current requirements, larger upset produced, and somewhat lower weld strength, flash welding is preferred and more widely used. However, the advantages which may be important in design are mainly that the flash spatter encountered with flash welds is not present and the upset or bulge produced is smooth and symmetrical with little or no extrusion of the metal, *Fig.* 3.

Flash-Butt Welding: Cross-sectional areas for flash welding may range to approximately 50 square inches generally and in special cases this has been increased to as much as 240 square inches. Joint face preparation is not so critical as in upset welding inasmuch as the arcing and flashing action burns away the irregularities to produce normal mating cross sections.

In order to obtain full advantage of the many economies afforded by butt welding, proper design of component parts is essential. Careful adherence to the limitations normally present and attention to

Fig. 7—Aerol shock absorber cylinder forged in two pieces and flash-butt welded to simplify the forging problem

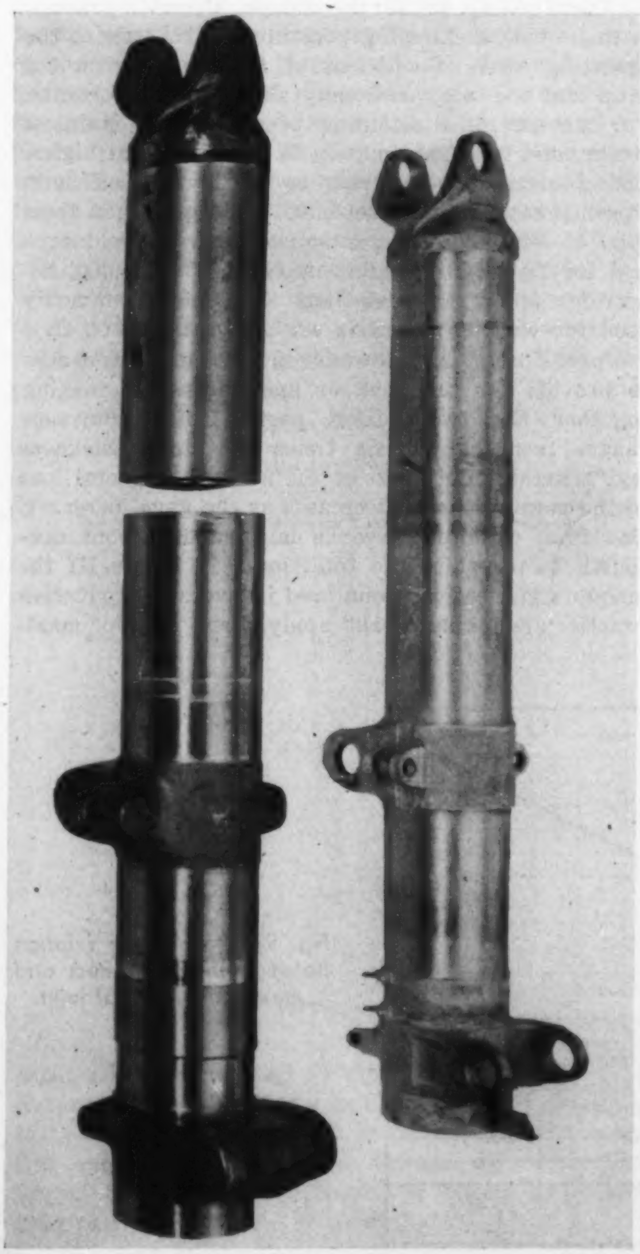


Fig. 8—Good and poor design practices regarding butt-welded joints

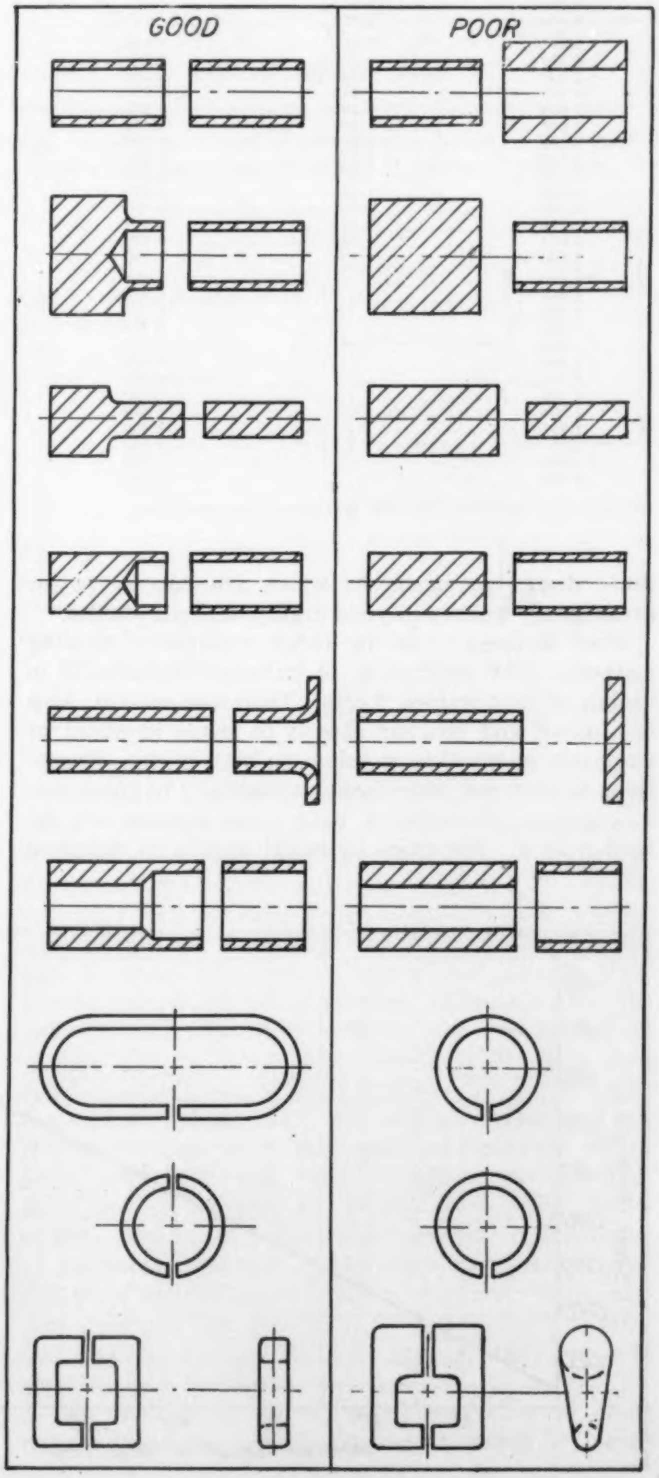


Table III*

Weld Allowances for Flash Welding Steels

(Material lost, inches)

Dimension	Tubes and Sheets	Solid Bars
0.010	0.060	
0.020	0.115	
0.030	0.175	
0.040	0.230	
0.050	0.280	0.050
0.060	0.330	
0.070	0.385	
0.080	0.435	
0.090	0.475	
0.100	0.520	0.082
0.110	0.570	
0.120	0.610	
0.130	0.650	
0.140	0.700	
0.150	0.730	0.120
0.160	0.770	
0.170	0.800	
0.180	0.840	
0.190	0.870	
0.200	0.900	0.150
0.250	1.010	0.180
0.300	1.120	0.210
0.350	1.210	0.250
0.400	1.290	0.285
0.450	1.350	0.320
0.500	1.410	0.350
0.550	1.465	0.390
0.600	1.505	0.425
0.650	1.555	0.450
0.700	1.610	0.480
0.800	1.675	0.540
0.900	1.730	0.600
1.000	1.800	0.660
1.050		0.690
1.100		0.720
1.150		0.750
1.200		0.780
1.250		0.810
1.300		0.840
1.400		0.900
1.500		0.960
1.600		1.020
1.700		1.080
1.800		1.140
1.900		1.200
2.000		1.260

* Courtesy, Resistance Welder Manufacturers Association.

those design requirements which are imperative for satisfactory welds will yield highly efficient results.

Heat Balance: As in other resistance welding methods, heat balance is of extreme importance in design of butt-welded joints. The cross-section, area of contact and contour should be made identical or as nearly identical as possible on both pieces. Exceptions to this rule have been successfully handled but, in general, the ratio of weld areas should not exceed 5 to 4. The mass of metal should be balanced so as to permit easy gripping and accurate aligment in welding. Good and poor design practices in regard to heat balance are shown in *Fig.* 8. Multiple flash-butt welds on the same part are practicable where the elements are of the same thickness and variation in areas not greater than 5 to 1.

Sheet and Tubing: To assure good production design, satisfactory welds and economy, certain limitations on length of joint with flat sheets and diameter of tubing must be observed. In *Fig.* 9, the recommended maximum joint length for flat sheets is shown and in *Fig.* 10 is that for tubing. Other sizes can be run but ordinarily incur excessive problems in production or result in only fair or poor joints.

Strength of Parts

Clamping Pressures: Design of parts to be butt welded should always take into consideration the clamping pressures required. The cross section must be sufficiently strong to withstand the pressure without distortion or crushing and to assure good electrical contact within the clamps. Common practice is to provide a clamping pressure 2½ to 3 times the upsetting force. Coefficient of friction between the jaws and the workpiece may also be of importance. For instance, the clamping pressure with stainless steels must be approximately 40 to 50 per cent higher than for mild steels owing to the lower coefficient. Upset pressure for upset-butt welding ranges from 2500 to 8000 pounds per square inch of weld area and for flash-butt welding, from 5000 to 25,000, depending upon the materials. Pressures commonly used for various materials are shown in Table II.

Upset Losses: An allowance must be made in design to provide for the flash or upset losses in forging together the two heated parts. Total allowance ranges from one to six times the stock thickness and generally the ratio of the amount of metal loss to the gage thickness decreases as the gage increases. The final pushup allowance is normally about one-fourth to one-third the total loss. In Table III the amounts generally encountered in average production practice are tabulated and apply where ratio of maxi-

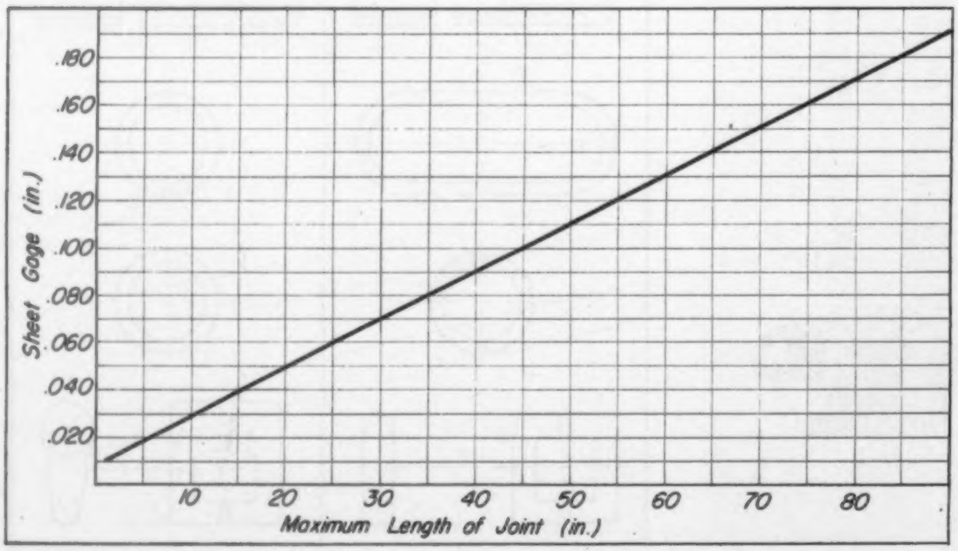


Fig. 9—Chart giving relation between sheet thickness and maximum length of joint

mum to minimum sectional dimension does not exceed 1.5 to 1. To be considered also along with upset loss is length of section necessary to accommodate the clamp. Usual clamp lengths are shown in TABLE IV.

Angle Joints: In welding corners or angle joints, it is well to avoid compact sections such as bars, squares, rounds, etc., where the angle between the parts is less than 90 degrees. To assure a satisfactory joint with good fusion at the outer corner, the angle should seldom be less than 150 degrees. Flat sections, however, can be welded satisfactorily to an included corner angle of 90 degrees if the length of joint is at least 20 times the stock thickness.

Design of Ends

End Preparation: For joining two solid parts, preparation of a matching extension on one of the pieces is recommended, *Fig.* 8. The length of extension to be used on some plain diameters may be found from TABLE III and IV. With solid sections larger than ¼-inch in OD, a small bevel is desirable on one of the pieces, *Fig.* 11, to aid in starting the flash. Very large sections may be beveled to a point as shown. Solid ends should be plain. Where turned parts have centers of appreciable size or depth in the ends to be welded, these should be removed to avoid poor fusion. Tubular extensions or joints should be beveled where wall gage is over 3/16-inch *Fig.* 12. If the variation in wall thicknesses exceeds 15 per cent, it may be advisable to consider a ring projection weld instead inasmuch as the variation for flash welding should be well below 15 per cent and preferably the areas should be equal. With flat sheets of 3/16-inch gage or greater, the face of at least one sheet should be beveled as shown in *Fig.* 13 to facilitate welding. The bevels and face of parts designed for flash welding need not be precise or extremely flat and with good surface contact as with upset parts. Cast, forged or machined bevels and faces are equally suitable.

TABLE IV†

Clamp Widths for Flash Welding

Dimension	Width with Locator	Width without Locator
0.250	0.375	1.00
0.312	0.375	1.00
0.375	0.375	1.50
0.500	0.375	1.75
0.750	0.500	2.00
1.000	0.750	2.50
1.50	1.000	3.00
2.00	1.25	*
2.50	1.75	*
3.00	2.00	*
3.50	2.25	*
4.00	2.50	*
4.50	2.75	*
5.00	2.75	*
5.50	3.00	*
6.00	3.25	*
6.50	3.50	*
7.00	3.75	*
7.50	4.00	*
8.00	4.25	*
8.50	4.50	*
9.00	4.75	*
9.50	5.00	*
10.00		*

† Courtesy Resistance Welder Manufacturers Association.
* Not recommended without use of backups.

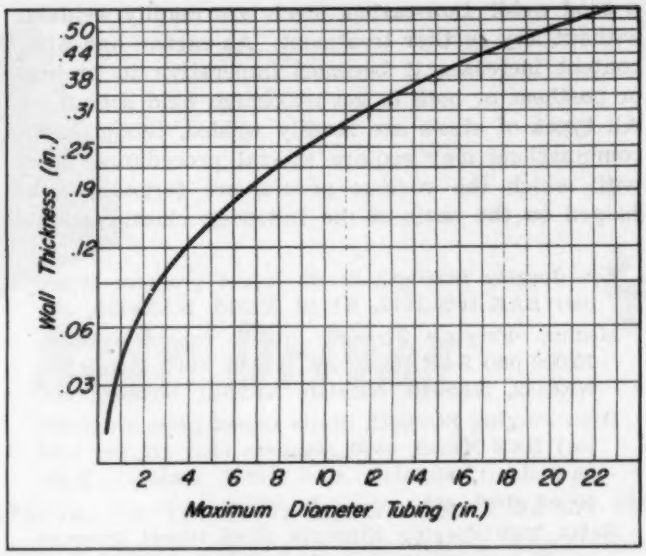


Fig. 10—Above—Chart of relationship between wall thickness and maximum diameter of tubing practicable

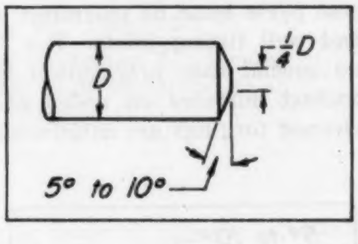


Fig. 11—Bevel design recommended for solid pieces over ¼-inch in diameter

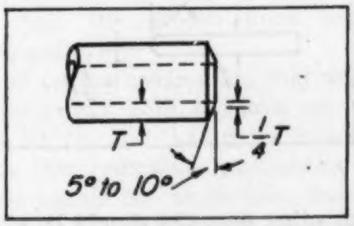


Fig. 12 — Tube-end preparation recommended for tubing over 3/16-inch in wall thickness

MATERIALS: All the various materials which are readily weldable by other resistance methods can be handled in flash welding. Upset-butt welding, as mentioned previously, is largely confined to ferrous materials. Upset welding of copper, copper alloys, magnesium and aluminum is not considered reliable and in some instances is impractical except with small-diameter parts. Aluminum alloys 2S, 3S, 53S and 61S are generally weldable by the flash-butt method but for mechanical reasons must be in sections greater than 0.050-inch thick. Of the brasses, high-leaded alloys may give brittle welds and, in general, brasses with high zinc content weld better than those with high copper content. As noted in the previous articles on resistance welding, weldability can be in part judged by the conductivity of the metal involved. Those high in electrical conductivity require much greater currents. Thus current required for aluminum is approximately 100,000 amperes per square inch whereas that for mild steel is only 20,000 to 30,000.

The weldability of steels is considered in great degree from the number of steps required to insure

a good weld. Low-carbon steels are readily weldable without any further treatment. As carbon and alloy content increases it becomes imperative to preheat or postheat or both to get maximum weld soundness. All types of steels are readily welded, though some combinations may require special procedures. Ease with which the various groups are forged can be judged on the basis of the following classifications:

Low forging Strength Steels (upset pressure 10,000 psi) SAE 1020,1112, X1112, X1315, NAX9115, etc.

Medium Forging Strength Steels (upset pressure 15,000 psi) SAE 1045, 1065, X1335, 3135, 4130, 4140, NE8442, NE8640, NE9440, NE9540, NE9640, etc.

High Forging Strength Steels (upset pressure 25,000 psi) SAE X4340, 4640, stainless iron (12 per cent chromium), stainless steel (18-8, cutlery), high-speed steel, etc.

Extra high Forging Strength Steel (upset pressure 35,000 psi) All steels with extra high compressive strength at elevated temperatures

Ordinarily, with upset welding, rolled, forged or cast parts must be machined to assure clean, smooth and well fitting joints. For flash welding however, no special face preparation is necessary. Electrode contact surfaces on rolled stock, stampings or grit cleaned forgings are satisfactory. Rust, scale, grease, or other deposits should be avoided as in other resistance work.

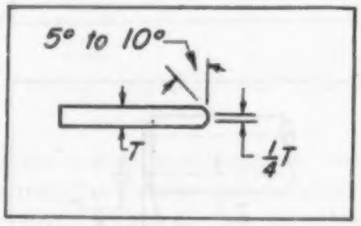


Fig. 13 — End preparation recommended for sheet over 3/16-inch in gage thickness

Dissimilar metals are most easily welded by the flash process and require less critical preparation. Even refractory type metals such as tungsten, molybdenum, and tantalum can be welded to other materials such as iron-base alloys, copper-base alloys and nickel alloys. Flash welding produces joints with the greatest strength and uniformity.

Flashless Joints

Percussive welding, although severely restricted as to size and complexity, makes possible the butt welding of round or tubular sections together or to flat surfaces in otherwise unweldable metal combinations. Steel can be welded to aluminum or magnesium, silver to copper, Stellite to ferrous or nonferrous materials, copper to aluminum, stainless steels or other corrosion-resistant materials to ferrous or nonferrous materials and where necessary, conventional metal combinations where no flash is acceptable.

TOLERANCES: Dimensional accuracy with butt welding can be unusually close and, as a rule, it is better with flash than upset work. Final accuracy of parts produced, however, will depend upon the accuracy of the parts prior to welding. Where close tolerances are necessary, the locating points and surfaces on the pieces and on the welder dies must be of equal or greater accuracy than that desired on the final weldment.

Diameter tolerances affect directly the offset or misalignment of the welded parts. Tubular or round ends, for instance, held to plus or minus 0.005-inch would result in a final possible misalignment or offset of 0.010-inch. In general, parts under 1-inch in diameter prepared with a tolerance of plus or minus 0.002-inch can be held to a concentricity of plus or minus 0.005-inch. With a tolerance of plus or minus 0.010-inch on a 6-inch diameter, a concentricity of plus or minus 0.030-inch can be held. Very small parts centerless ground to close limits are often practical to hold to total runout of 0.004-inch, maximum.

Length or overall dimension of the welded assembly is also influenced by the preset tolerances of the individual parts. If welded without locators, the final length tolerance after welding will be equal to the sum of the tolerances before welding. If backup locators are used, the final length tolerance will normally be less than that of one piece; the accuracy being largely set by the locator spacings. For best results, length tolerance on the parts to be welded should be kept to plus or minus 0.010-inch or better. Final length tolerance in such cases will be less than plus or minus 0.010-inch. Flash welded parts with two joints to take into consideration, under the same preliminary tolerances, can be held to plus or minus 0.031-inch or better on overall length.

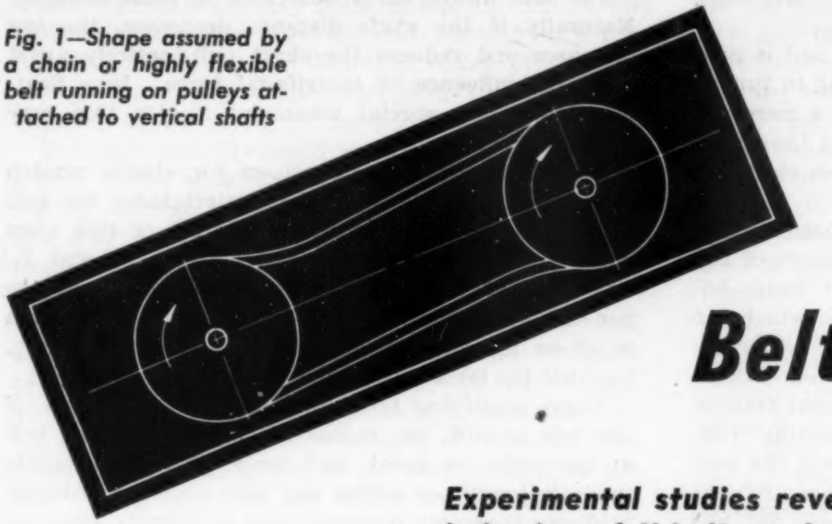
Collaboration of the following organizations in the preparation of this article is acknowledged with much appreciation:

Chrysler Corp. (*Fig.* 2) .... Detroit, Mich
Cleveland Pneumatic Tool Co. (*Fig.* 7) ... Cleveland, Ohio
Douglas Aircraft Co. (*Figs.* 4, 5, 6) .. Santa Monica, Calif.
Federal Machine & Welder Co. .... Warren, Ohio
General Electric Co. .... Schenectady, N. Y.
P. R. Mallory & Co. (TABLE II) .... Indianapolis, Ind.
Resistance Welder Manufacturers Association
(*Figs.* 1, 9, 10, 11, 12 & 13) .... Philadelphia, Pa.
Sciaky Bros. Co. .... Chicago, Ill.
Taylor Winfield Corp. .... Warren, Ohio
Westinghouse Electric Corp. .... Pittsburgh, Pa.

They Say . . .

"We hear a lot of name-calling today based on man's unwillingness to work—the high pay demands—the prerogatives of management and a lot of other fancy catch-penny phrases. There are elements at work today in our economic body that would widen the gap between the worker and the employer and make great gains out of the ensuing chaos. We cannot stop the trend with words. We cannot increase our efficiency by fancy slogans. We must go in direct action with intelligent plans directed at the sagging points in our industrial foundation." — ARTHUR J. WIELAND, *Willy-Overland Motors, Inc.*

Fig. 1—Shape assumed by a chain or highly flexible belt running on pulleys attached to vertical shafts



Belt Drives

Experimental studies reveal little known facts about the behavior of V-belts under rigorous operating conditions

By C. A. Norman
Department of Mechanical Engineering
The Ohio State University
Columbus, O.

WHAT is the belt tension that will insure dependable power transmission and reasonable belt life, even under sustained heavy load? Need for an answer to this question, with particular reference to front-end belt drives on certain automotive vehicles, prompted the Goodyear-sponsored investigation discussed in this article. These drives involve high speeds, small contact angles, and also small pulley diameters. It was therefore necessary to determine the influence of contact angle on transmissive power with the small pulley diameters used. The project, then, involved all the fundamentals of power transmission with modern V-belts.

Among the phases studied were the effects of centrifugal force, fixed and floating drives, angle of contact, ratio of pulley diameter to belt thickness, and ratio of total tension to initial tension.

CENTRIFUGAL FORCE: It was found that centrifugal force may have much less influence than commonly assumed. This is true particularly for belts with small elastic stretch, such as belts with steel-wire transmitting elements; but is fairly true also for other modern V-belts, except that belts with textile transmitting elements may slip somewhat more than steel-wire belts.

In this country the basic formula for belt transmission has been

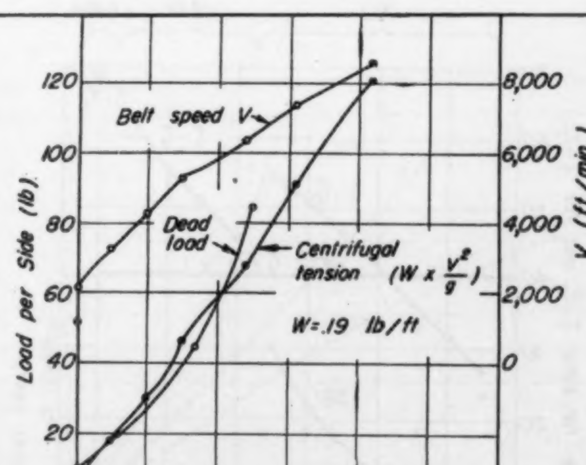
$$\frac{T_1 - \frac{wv^2}{g}}{T_2 - \frac{wv^2}{g}} = e^{f\alpha/\sin\gamma} \qquad (1)$$

where T_1 = tight side tension, lb; T_2 = slack side tension, lb; w = weight of belt, lb per ft of length; v = belt speed, ft per sec; g = gravity acceleration, ft per sec per sec; e = basis of natural logarithms; α = contact angle, radians; f = coefficient of friction; and γ = half the groove apex angle (γ = 90 deg for flat pulleys).

Equation 1 is derived on the assumption that when the belt runs over the pulley both tensions are reduced by the amount wv^2/g, and that there is nothing to compensate for this reduction. According to this formula, if wv^2/g equals the slack side tension T_2, power transmission ceases, since $T_1 - wv^2/g$

Based on a paper presented at a meeting of the Machine Design division of ASME during the recent annual meeting of the society in New York.

Fig. 2—Results of centrifugal force tests with C-105 smooth cotton V-belt on 9-inch OD pulleys



would then also have to become zero, $e^{f\alpha/\sin\gamma}$ not being equal to infinity.

This, as was realized earlier in Europe and is now becoming realized in this country, is wrong in fundamental theory and amounts in practice to a mere approximation which is more and more wrong the slacker the belt can run, and the less it stretches elastically.

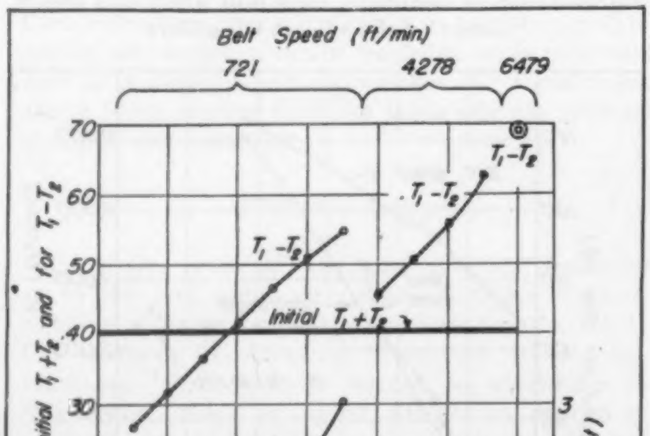
The point is this: The centrifugal tension term wv^2/g contains neither the radius of curvature of the belt, nor the contact angle. Now the belt hangs between the pulleys in some sort of a curve, which for a perfectly flexible belt and a horizontal or moderately inclined drive would be a catenary. Hence there is also in this part of the belt a centrifugal tension wv^2/g which adds itself to the tension resulting from the weight. This tension increment between the pulleys would exactly compensate for the centrifugal reduction on the pulleys; and *if the belt did not stretch* the centrifugal force would have no influence on the transmissible power at all.

Centrifugal-force tension, however, stretches the belt, and while this has no effect on the centrifugal tension itself, it does have an influence on the tension caused by the weight of the belt. This tension will decrease with increased sag, i.e., with the stretching of the belt. Hence, since the centrifugal tension stretches the belt, if it is at all stretchable, it will reduce the tension due to weight. Formulas to allow for influence of centrifugal force must therefore contain terms reflecting the influence of the tension on sag and belt length.

A complete formula* for this influence in the case of a horizontal, idling belt shows that the difference between the standstill shaft pull per side, T_0, and the running shaft pull, T_s, is equal to the old-time quantity wv^2/g, modified by three terms.

* See *High-Speed Belt Drives*, Engineering Experiment Station Bulletin No. 83, Ohio State University.

Fig. 3—Comparative speed tests with C-96 smooth steel-cable V-belt on 9-inch OD pulleys, locked center distance



The first allows for a difference in shaft distance. Naturally if the shaft distance decreases, the sag increases and reduces the shaft pull, entirely apart from the influence of centrifugal force. In a floating drive with special tensioning device this may well occur.

Second modifying term allows for elastic stretch in the belt. The less elastically stretchable the belt is, the greater is the modifying effect of this term and the smaller the difference between T_0 and T_s. The same effect is produced by great belt weight w per inch of length, and by long center distance. This is all on the assumption that T_s is smaller than T_0, i.e., that the term wv^2/g predominates.

Third modifying term allows for belt stiffness. If the belt is stiff, the radius of curvature of the belt at the pulley is great, and for a given belt length, the belt length on which sag may occur is reduced. Stiffness therefore decreases the slackening effect of centrifugal force.

Factors Affecting Belt Shape

Before proceeding to a discussion of the tests it should be remarked that centrifugal force, as such, does not bulge the belt and in fact gives the belt between the pulleys no definite shape whatever. A chain mounted on vertical shafts takes the shape shown in *Fig.* 1. The bending-in where the chain leaves the pulley is due to inertia effects in the links, not to centrifugal force. It can be eliminated by arranging the pivot points of the links so that the chain tension exerts a righting moment.

A perfectly flexible belt would behave similarly. If a belt bulges, this is due merely to stiffness and actual tests show that the bulging force is no greater at 7000 fpm than it is at standstill. All this is of course in harmony with the fact that neither the radius of curvature nor the included angle appears in the formula for the centrifugal tension wv^2/g.

In *Fig.* 2 is shown a plot of idling tests run to verify the stretching action of the centrifugal force. The driven pulley was mounted on a sliding carriage and the belt was a smooth cotton V-belt which is fairly stretchable elastically as modern belts go. The pull on the driven shaft was first held barely sufficient to keep the belt running straight. The increase in center distance as the belt was speeded up to over 8000 fpm is plotted as abscissa. The belt was then idled slowly at 70 rpm and dead loads were applied at the driven end to produce a stretch equal to that produced by the previous centrifugal force. The practically perfect agreement between the computed centrifugal tension wv^2/g and the dead load per side for equal stretch should be noted.

The really important test results are typified by *Figs.* 3 and 4. *Fig.* 3 shows that it is possible to transmit not only as much, but actually more, effective pull at high speed than at low speed. This applies up to speeds of over 6000 fpm and also was verified for two different lengths of steel cable V-belt at two different initial tensions. The slips, while they increase with the load, do not seem to increase with the speed for constant load. Now steel-

cable belts stretch very little elastically, but it was also shown that the same situation obtains for a cotton-strand V-belt. The absolute values of the slip are greater than for the steel belt, but do not increase with the speed for equal effective pulls.

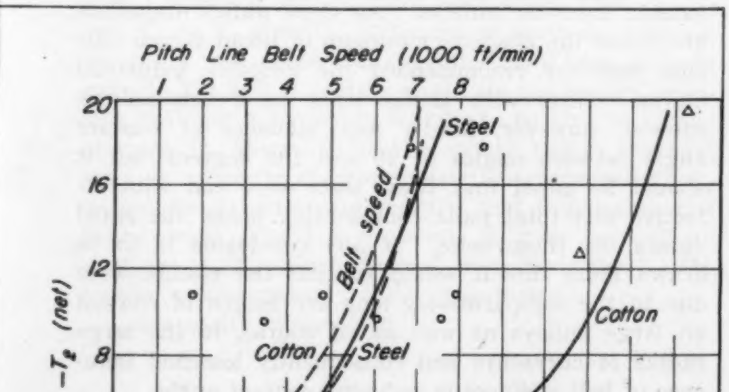
The tests just discussed were carried out on horizontal drives with the driven shaft journaled in a sliding carriage and the torque taken through a flexible shaft to a Prony brake. The shaft distance was locked after the initial tension had been set by dead weights.

In the tests reported in *Fig.* 4 the driven shaft carried a calibrated fan. The pulleys were the same as before, but the belts were only 68 inches long. They were of steel-cable type as well as cotton-cord type. The main interest centers in showing the very much greater slip of the cotton-cord belts. The slip was also greater for the stiffer smooth belts than for the more flexible notch belts.

The fact that a belt on a fixed shaft distance can transmit more effective pull at high speed than at low is of course no new discovery. It has been referred to in some recent textbooks on machine design and also in other publications. Yet the author does not believe it has been emphasized that the matter has been so well established in Europe by practcial experience that a leading belt firm in Hamburg actually recommended effective pulls, on large pulleys, increasing all the way up to a belt speed of 10,000 fpm.

It may be well to point out that the centrifugal tension in the belt between the pulleys is demanded by Newton's third law, which states that an action is balanced by an equal reaction. Assume for simplicity a horizontal drive with equal pulley diameters. Let the applied tension, T, in the belt be zero. The outward-directed centrifugal force at each end sets up a tension wv^2/g which tends to pull the belt apart. As long as the force does not rupture the belt this tension must be balanced by an equal force wv^2/g in the portions of the belt between the pulleys.

Fig. 4—Comparative high-speed tests with C-68 notch belts on 9-inch OD pulleys, with drive locked at $T_1 + T_2 = 30$ lb



If the belt does not stretch, the intimacy of contact between the belt and the pulley is not changed by the centrifugal tension. The pressure between pulley and belt will be determined by any applied initial tension T_0. If the belt stretches, the tension T_0 will be influenced by the sag, and the belt pull against the pulleys will be determined by the sag condition. With vertical belts, stretch due to centrifugal tension may actually pull the belt free of the lower pulley.

Fixed and Floating Shaft Distance: The new and somewhat surprising thing shown in *Fig.* 3, as already pointed out, is that with fixed shaft distance it is possible to transmit an effective pull $T_1 - T_2$ greater than the initially applied total tension $T_1 + T_2$. There is one possible explanation of this phenomenon which, however, will apply only to certain types of belts. For short or vertical belt drives Carl G. Barth suggested a formula for the relation between the initially applied tension per side T_0, and the working tension T_1 and T_2

$$\sqrt{T_1} + \sqrt{T_2} = 2\sqrt{T_0} \qquad (2)$$

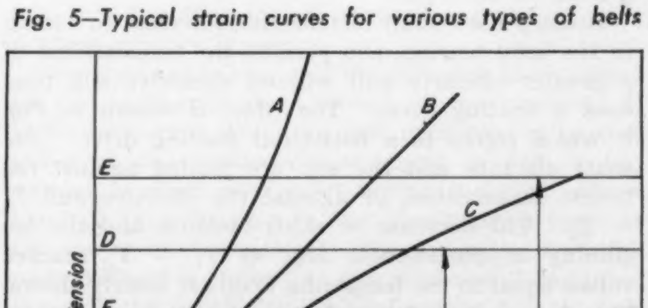
This formula, however, applied only to belts the stress-strain curve of which would run as curve A in *Fig.* 5, that is to say, the relation between belt length l and tension T could be represented by an equation $l = a + b\,T^m$, where a and b are constants, and m an exponent less than unity.

For such a relation, as *Fig.* 5 shows, an increase in tension from T_0 to T_1 on the tight side would correspond to a smaller stretch than for an equal amount of tension drop from T_0 to T_2 on the slack side. Hence, as load was applied, the belt would shorten. If the shaft distance was kept constant, the belt would tighten.

If the stress-strain relation is linear as represented by curve B, the extension on the tight side would equal the shortening on the slack side, and the belt length would remain constant. With such a relationship

$$T_1 + T_2 = 2\,T_0 \qquad (3)$$

Fig. 5—Typical strain curves for various types of belts



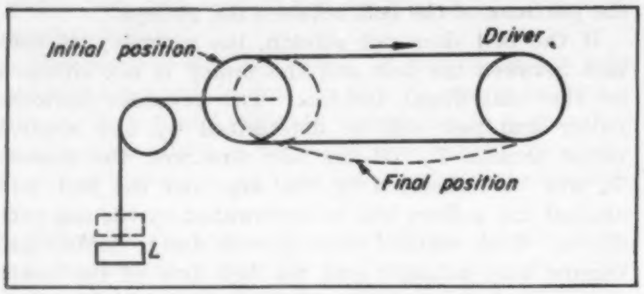


Fig. 6—Floating belt drive, showing method of applying initial tension for the test set-up

Finally, if the stress-strain curve bends toward the strain axis, as curve *C* in *Fig*. 5, the extension on the tight side would be greater than the contraction on the slack side. The belt length would increase with the load and

$$T_1^n + T_2^n = 2T_o^n \quad (4)$$

where n is greater than unity. Total tension under load would be smaller than the initial tension, and the effective pull transmissible with fixed shaft distance would be smaller than the load transmissible with a floating drive.

In stress-strain determinations at the Ohio State University it was found that the majority of V-belts had stress strain-curves of type *C*. In spite of this they transmitted more load with fixed shaft distance than with floating drive.

The question was cleared up by mounting the driven shaft on a sliding carrier, as in *Fig*. 6. The driven shaft either carried a fan, or was connected through a flexible shaft to a Prony brake.

It was found that when the tension on the slack side approaches zero, if excessive slip does not occur the drive becomes a hoist, the tight side pulling the driven pulley toward the driving pulley. This of course increases the slack and decreases the contact angle on the pulleys so that increased slip and, finally, breakdown of the drive occur. To keep the shaft distance constant, it is necessary to increase the load L. This increases the contact angle, as well as the tensions, and permits the transmission of a greater effective pull.

Hence a fixed shaft distance is equivalent to adding to the total tension, and permits the transmission of a greater effective pull without excessive slip than does a floating drive. The effect is shown in *Fig*. 7, which refers to a horizontal floating drive. The shaft distance and the slip are plotted against the torque transmitted, or against the effective pull $T_1 - T_2$. The decrease in shaft distance and the beginning of considerable slip, as $T_1 - T_2$ reaches values equal to the tensioning load, are clearly shown. This figure represents only one of a number of tests both with fan load and Prony brake load, and with different speeds. At higher speeds the decrease in shaft distance came even before the slack side tensions approached zero. The graph should be taken merely as a qualitative illustration of what takes place.

A horizontal drive with a nominal contact angle

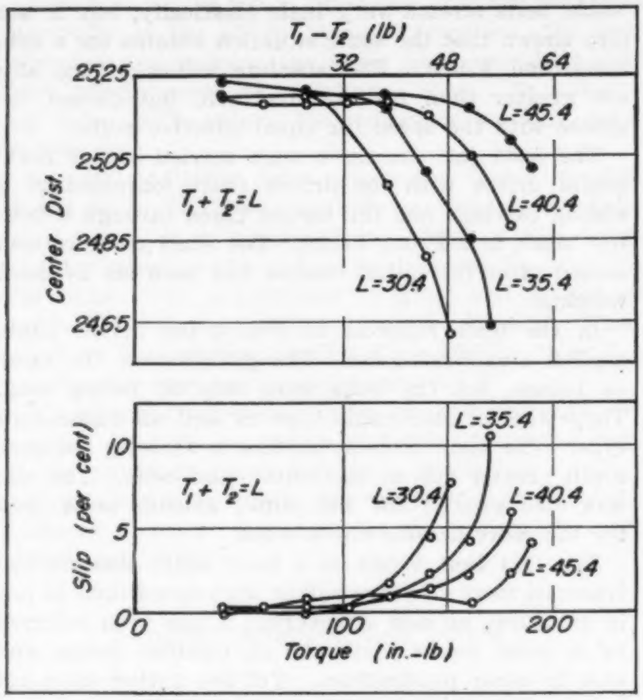


Fig. 7—Change in center distance, and slip, with floating drive using C-68 smooth steel-cable V-belt

of 180 degrees represents, of course, the most favorable condition for transmitting large effective pulls, $T_1 - T_2$, even with very low slack-side tensions. With smaller contact angles, such as occur in a three-point drive, the higher transmissive power obtainable with fixed shaft distance might not be so noticeable. This advantage therefore had to be established by direct tests on such drives, as reported in the following, which showed that with the same initially applied tension, more effective pull could uniformly be transmitted with fixed shaft distance than with a floating tensioning device. The advantage of the floating drive with tensioning device lies in compensating for permanent belt stretch.

CONTACT ANGLE: The first test results to be plotted were for C-size belts on 6.9, 5.0 and 4.0-inch outside diameter pulleys. All these pulley diameters are below the absolute minimum of about 9-inch outside diameter recommended for long-life industrial drives. Tests with C-size belts on 9-inch pulleys showed, however, hardly any influence of contact angle between angles of 90 and 180 degrees, but it should be noted that these tests were run with effective and total pulls considerably below the rated values for these belts. If any conclusion is to be drawn from this it would be that the results were due to the comparatively long arc length of contact on large pulleys as well as, of course, to the large radius of curvature and consequently lessened influence of belt stiffness in reducing contact angle.

Strange to say, a similar independence of contact angle may be observed also on very small pulleys, *Fig*. 8. The reason then is that belt stiffness reduces the actual contact between belt and pulley almost to a point for all angles.

If it is assumed that $T_1 - T_2$ is zero for contact angle $\alpha = 0$, it would seem that the best compro-

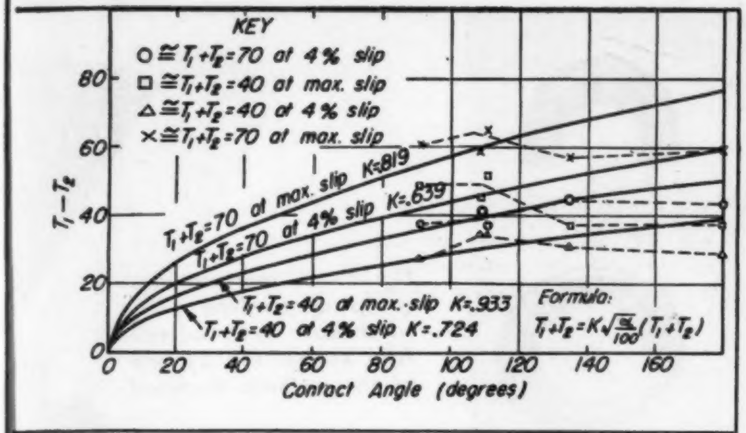


Fig. 8—Contact-angle curves for B-60 smooth cotton V-belt with floating drive and 3½-inch OD pulleys

mise formula to suggest is of the form

$$T_1 - T_2 = k\sqrt{\frac{a}{100}}\,(T_1 + T_2) \quad \text{(5)}$$

where k is an experimental constant.

As *Fig.* 8 and similar plots show, this formula represents acceptably the relation for B-size belts on 5-inch outside diameter with sizable loads. It does this for smooth cotton V-belts and steel-cable notch belts, and for fixed shaft distance ("locked" drives) as well as for floating shaft distance ("unlocked" drives). For a comparatively stiff, smooth cotton belt on pulleys of only 3½-inch outside diameter there is a tendency for the experimental plots to run flat, in harmony with the idea above set forth that the actual contact angle is then very small in all cases.

From the practical point of view a formula giving the effective pull $T_1 - T_2$ directly from the total pull $T_1 + T_2$ is decidedly preferable to a formula giving T_1/T_2. The use of T_1/T_2 as a belt drive characteristic springs merely from the theoretical formula, Equation 1, when wv^2/g is neglected.

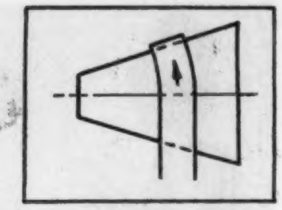
Since values of the coefficient of friction f in Equation 1 must be derived from tests which give $T_1 - T_2$ and $T_1 + T_2$ directly, and must be derived under assumption of a contact angle which may have little to do with the actual contact angle, its use is very much like building a mountain merely to be able to tunnel through it. However, as the author has in the past been an advocate of experimentally determined T_1/T_2 values as a belt characteristic, and this usage has found wide spread acceptance, it may be well to compare T_1/T_2 values derived from Equation 5 with values now commonly used in industry.

It can easily be seen that

$$\frac{T_1}{T_2} = \frac{(T_1 + T_2) + (T_1 - T_2)}{(T_1 + T_2) - (T_1 - T_2)} = \frac{1 + k\sqrt{\frac{a}{100}}}{1 - k\sqrt{\frac{a}{100}}} \quad \text{(6)}$$

Values of k_1 (for floating drive) and k_2 (for locked drive) for use in computation practice must, for the present, be settled by recourse to general practical experience. A designer who wishes to play perfectly safe even for small pulleys may take $k_1 = 0.5$. With reasonably large pulleys k_1 values of 0.6 might readily be attained.

Fig. 9 — Action of pulley crown in maintaining belt on pulley



It was found that in only one case was k_2/k_1 less than 1.1, while in many cases it was considerably higher. Hence it is conservative to say that at least a 10 per cent higher effective pull can be transmitted with fixed shaft distance than with a floating drive, the initially set $T_1 + T_2$ value being the same; provided, of course, permanent stretch is still inconsiderable.

It should be noted that where the shaft distance, and hence the belt tightness, is readily adjustable it is advisable to lock the shafts while the drive is idling slowly, since then there is assurance of an even tension all around the drive.

Minimum Crown on Flat Pulleys

FLAT-BELT PULLEY CROWN: Pulley crown tests at the Ohio State University had been preceded by so called crown-conformation tests at Akron. These indicated that wide modern belts, particularly with steel-cable transmitting elements, might not conform to the pulley rim at the edges, unless the crown was quite low. This of course would have a tendency to concentrate the power transmission of the belt toward its middle section only, which could not have a favorable effect on the life of the belt. The question then arose how much crown was absolutely necessary to prevent the belt from running off the pulleys.

Initial orientation tests showed that a crown of 0.06-inch on the diameter per foot of pulley width was sufficient to steer the belt, *but only if the shafts were specially aligned for each belt.* A crown of 0.10-inch per foot was necessary to guide all belts without special alignment.

The observed behavior of the belts can be explained by the commonly given theory of crown effect. It is assumed that when the belt runs onto a tapered pulley it flexes sideways as shown in *Fig.* 9, i.e., contact is made at a point nearer the high end as the belt runs on than is the simultaneous point at the center of belt contact. The wider the belt, the more difficult it is for it to flex sideways. The higher the pull, the greater is the tendency to pull the belt straigh and reduce the possibility of sidewise bending.

A wider belt would no then be guided by a crown as effectively as a narrow belt, and a heavily loaded belt would not be guided as effectively as a lightly loaded one. Both conclusions are in harmony with the test results here reported.

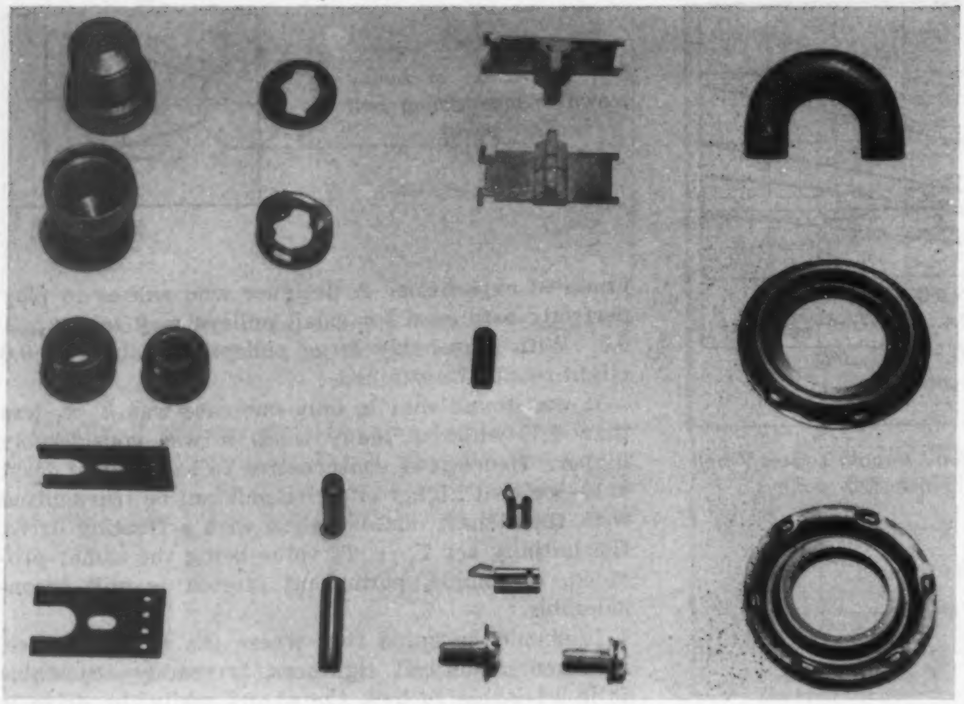
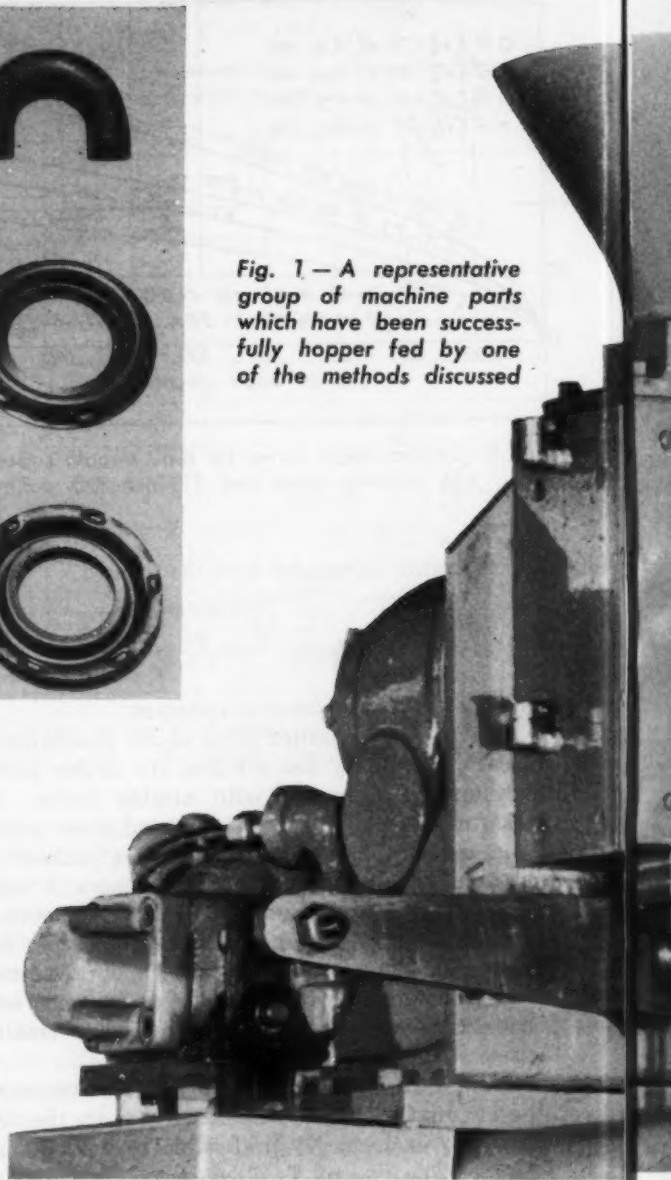


Fig. 1 — A representative group of machine parts which have been successfully hopper fed by one of the methods discussed



Hopper Feeds

Basic types and their design

By Charles E. Kraus

President

Kraus Design Inc.

Rochester, N. Y.

ALTHOUGH the automatic handling of a great variety of materials or workpieces is common practice, recent trends in labor cost and productivity have increased the demand for such equipment. For many industries and types of work, relatively complete automatic equipment has been indispensable for years, and in fact, some industries owe their existence to the development of such equipment. Examples such as bottling, wrapping and packaging, and cigarette manufacturing come quickly to mind.

In manufacturing industries involving machined, molded, stamped or similar components, adoption of automatic methods has been retarded by many factors. Production figures, in the millions per year, are high in this field, but are small compared to the figures for pills, packages and pop. Most of such equipment is single-purpose, or at best, will handle a restricted range of similar sizes, while continual design changes result in expensive and time consuming changes in equipment. Perhaps the greatest single retarding factor, however, is the tremendous variety of pieces to be handled, pieces which vary not only in size, shape, weight, material, fragility and finish, but which also require handling or motions, or work done to them or by them, in equal variety, *Fig.* 1.

In the development of such automatic equipment, one starting point is common to all. The workpiece or material, whatever its nature, must be presented in controlled and orderly fashion. The use of material in strip, wire, tube forms, etc., common in first-stage processing, suggests a method that often can be extended to subsequent processing or assembly; namely, by retaining connecting material or by temporarily attaching to a carrying strip. Many times it is feasible to make parts as needed and where needed, for assembly or additional processing. For example, springs can be wound and inserted or attached, and pieces such as stampings, felt inserts, etc., made as required. In most cases,

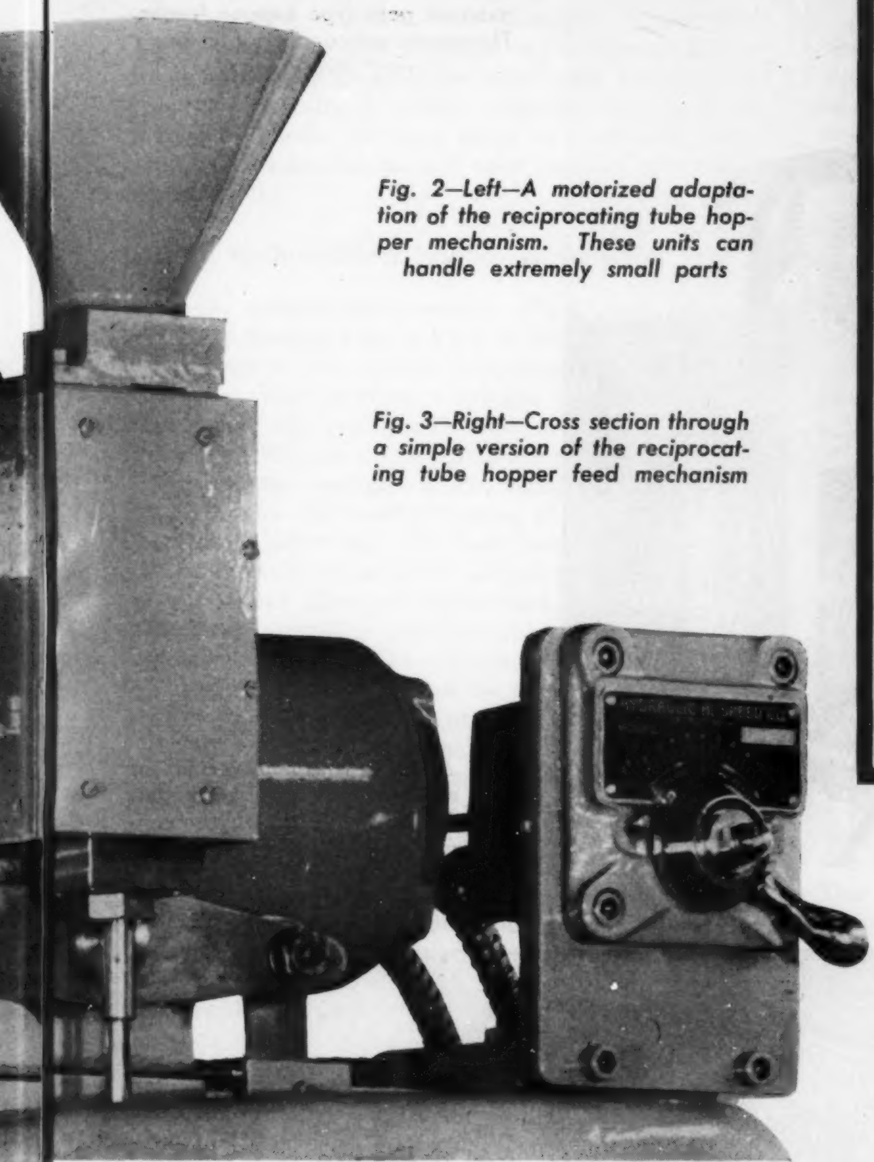
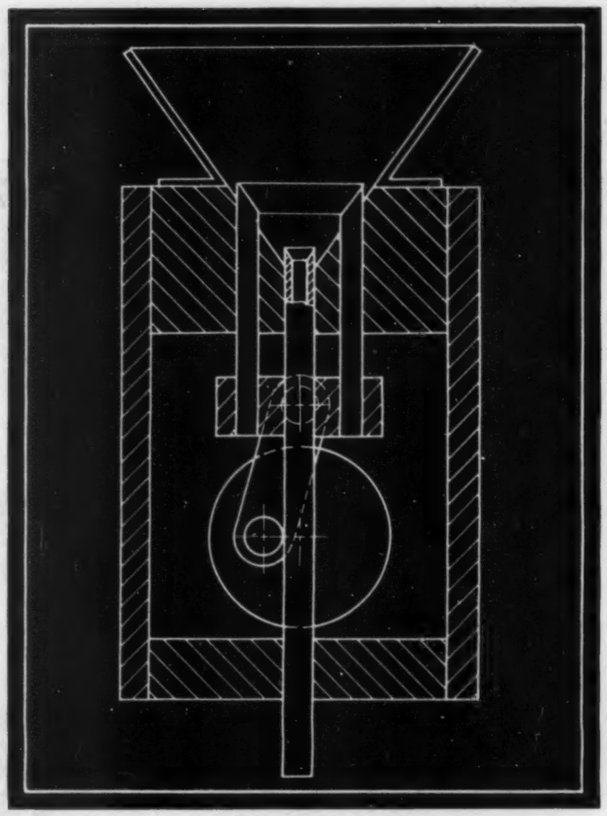


Fig. 2—Left—A motorized adaptation of the reciprocating tube hopper mechanism. These units can handle extremely small parts

Fig. 3—Right—Cross section through a simple version of the reciprocating tube hopper feed mechanism



however, the problem evolves into one of handling parts in bulk.

MAGAZINES AND HOPPERS: The two most important devices or methods for taking parts from bulk, or an uncontrolled state, and presenting them in a controlled and orderly fashion, are magazines and hoppers. Because these terms are not ordinarily well defined and are sometimes used in an overlapping sense, they are here defined for the purposes of this article as follows: A magazine is considered to be a mechanism which must be loaded with stacked parts, usually orientated in some definite way; a hopper is a mechanism into which the parts are dumped, without regard to position. Obviously, such clean-cut definitions do not cover the many variations, since hoppers may require loading with some orientation, and magazines frequently handle completely symmetrical parts. Magazines almost always present parts one at a time in exact position, and are synchronized with the machine they serve. Hoppers usually discharge untimed successions of pieces into chute or conveyor handling means, and may or may not orientate the pieces in all the desired ways. Hoppers frequently require additional orientating mechanisms and devices to control feeding and positioning of parts where needed.

The complexity and infinite variety presented by even restricted portions of this extensive field of design, limits an article such as this to the presentation of a few specific methods. Most design and production men are fairly familiar with the various standard types of hoppers on the market for handling screws, washers, bottle caps, rivets, etc. Consequently, the discussion in this article is directed mainly to a few general hoppering methods of a relatively versatile nature, and it is intended by inference to indicate the range and type of workpieces which can be succesesfully handled, *Fig.* 1.

Tube Type Feeder Almost Foolproof

RECIPROCATING HOPPERS: A motorized adaptation of a reciprocating tube type feeder is shown in *Fig.* 2. The conical receptacle contains, in this case, pins about 3/32-inch in diameter, and ½-inch in length. The reciprocating tube is actuated by a cam on the reducer shaft. Interesting features of this design are the telescoping construction which allows the delivery tube to be stationary, and the use of auxiliary pins to agitate the pieces and prevent bridging over, or "holing-through" action. Properly designed, this sim-

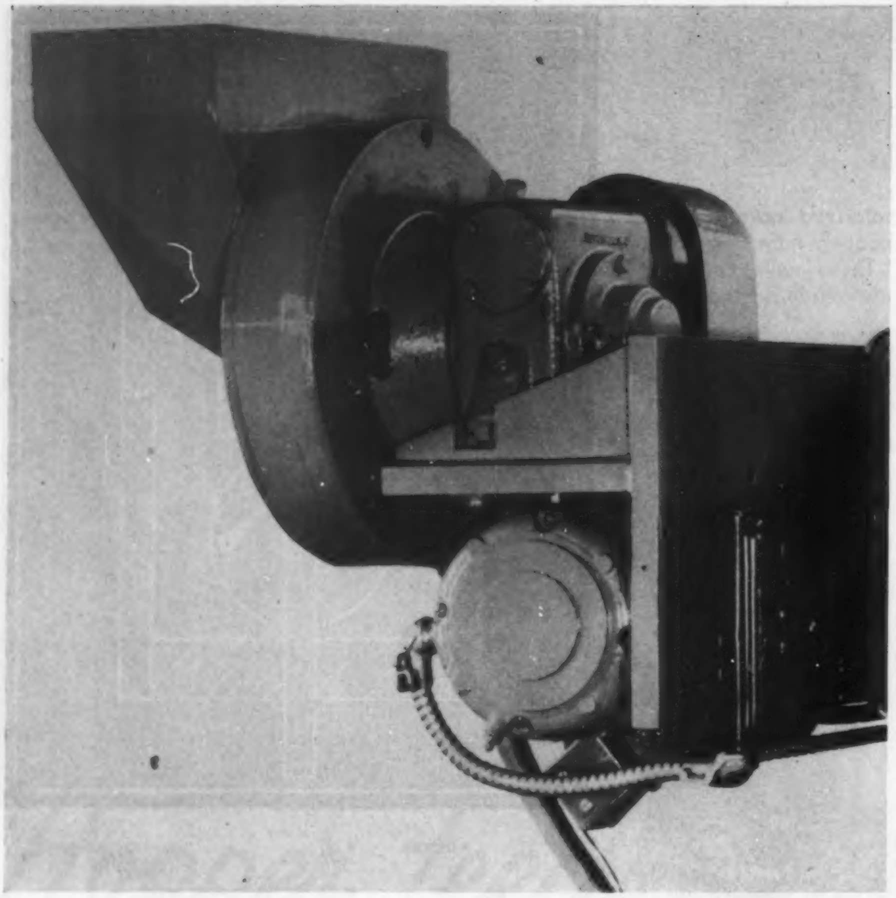
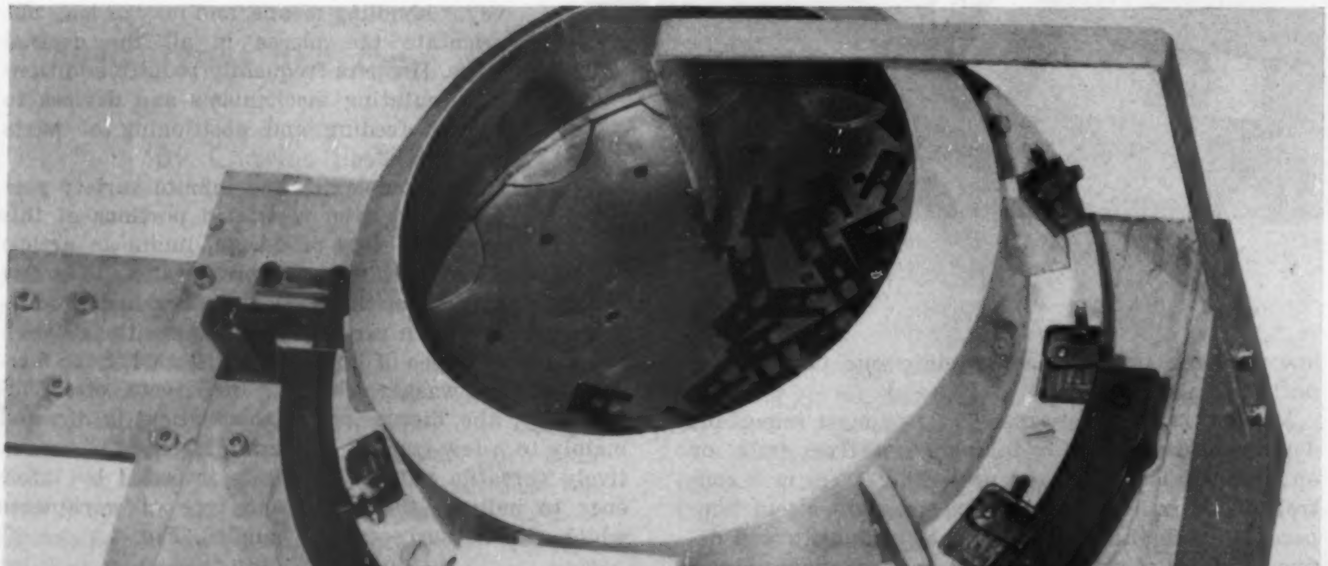


Fig. 4—Left—Vertical model of the external gate type hopper feeder. These units are capable of handling very large parts

Fig. 5—Below—Inclined version of the external gate hopper feeder. Rotation of these units may be constant, intermittent or indexing



ple hopper will give almost foolproof operation and a steady flow of parts. Modifications include hoppers designed to feed multiple outlet tubes, the use of coil spring delivery tubes, and crank drives which may be adjustable in stroke. Hoppers have been designed to handle parts as small as 0.030-inch diameter, and within limits, will take parts of more than one diameter.

Reciprocating Hopper is Versatile

In the diagrammatic section, *Fig.* 3, a version of the reciprocating tube hopper is shown. Workpieces are placed in the conical receptacle and feed down the tube which is given a vertical movement by the crank and connecting rod. The crosshead block is guided in this case by two pins which also act as agitators for the workpieces. The number, position, and even the need for these pins often is a case for experimentation, as is also the form taken by the upper end of the tube. As a rule, a simple coned-end suffices and is better than an angular-end cut. The stroke and speed should be adequate for safe delivery rate but should be as low as practical. Care in the design of bearings and seals must be exercised if abrasive dirt or fine chips are present.

External Gate Hoppers: The hopper shown in *Fig.* 4, may be described as an external gate type. These hoppers are versatile, and on some symmetrical parts are capable of very high delivery rates. Primarily adapted to circular parts larger in diameter than in thickness, external gate hoppers can handle parts requiring orientation, and in some cases can be designed to handle a reasonable range in part size. Hoppers of this design have also been successfully applied to parts which nest badly. Because these hoppers can be operated at widely varying speeds, it is best to provide an adjustable speed drive, inasmuch as no mechanism should be driven at a speed higher than required for a safe delivery rate. It is almost always necessary to use some means of positively stripping the gates and upper chute path, and in the case of fragile pieces, there is some danger of damage. Designs for this type of hopper have ranged from 3 to 36 inches in diameter.

Basically, this is perhaps the earliest and most used of all designs and has been built in untold variations. It may be vertical as in *Fig.* 4 or inclined as in the modified version in *Fig.* 5. Rotation may be constant, intermittent, or by index means. Where index drive is used, delivery need not be radial, and this characteristic frequently assists in applying other auxiliary mechanisms. The line diagram, *Fig.* 6, serves to illustrate the typical design of a simple version of this type hopper. The reducer, driven by a motor not shown, rotates the gate disk. In this case, the gates are simply pins, but often the gates are milled slots to suit the workpiece. The workpieces are placed in the hopper and find positions between the gate pins. A recess in the case allows the pieces to slide down into the feed chute. If the chute and recess is full, the pieces stay in the hopper and recirculate until the chute is again feeding.

How the basic external gate design may be altered to suit special cases is indicated in *Fig.* 5. Here the hopper is inclined, the rotation is by pin geneva, and the outlet to the chute is at the bottom index position only. The pieces being hoppered are light plastic rectangles about 1/32-inch thick, and have a pronounced tendency to wedge at the exits. At the side of the hopper, a reciprocating slide clears each gate as it stops on index. Delivery control is effected by a magnetic gate which opens when pieces are needed. The exit gates in this hopper are tunnels, and are not faced on one side by a stationary plate, *Fig.* 6. This construction has disadvantages, but is often necessary to avoid damage to parts.

Parts Position Themselves

Recirculating Hoppers: Of the many basically different methods of hoppering parts, one other method is sufficiently versatile to warrant discussion. Many parts, when made to fall on or move towards a selector device which may be a simple rail or groove, will be found to position a usable proportion of themselves correctly and proceed along a prescribed path. Those that do not may be allowed to

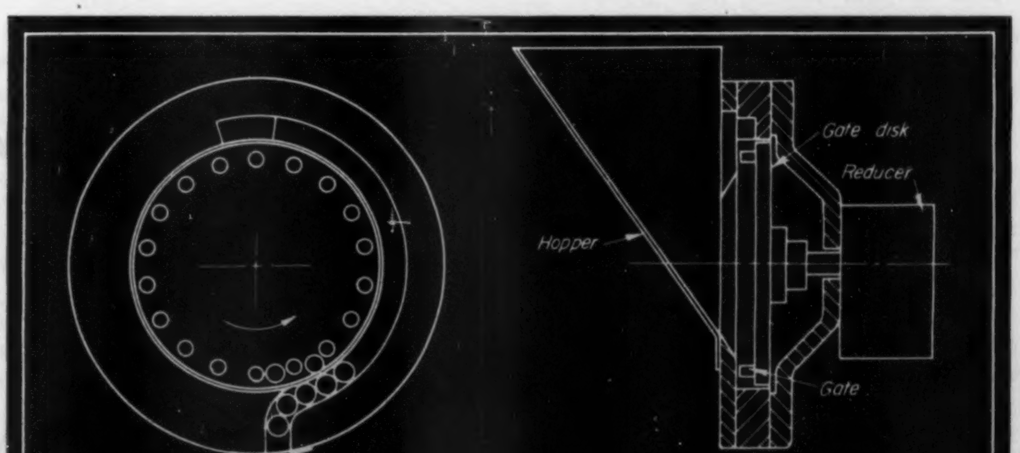


Fig. 6 — Cross section through the external gate hopper design shown in Fig. 5

fall free or be dislodged by any number of means. The hopper design then becomes a matter of arranging a recirculating mechanism to continually move controlled numbers of parts to a suitably designed selector. These hoppers sometimes become quite complex and frequently require considerable development. The circulatory means may vary from a conveyor system taking parts from a bin even at some distance from the hopper, to a simple horizontally rotating disk. The selector may be stationary, reciprocating, oscillating or equipped with a vibrator and may be arranged to orient the parts in various different ways.

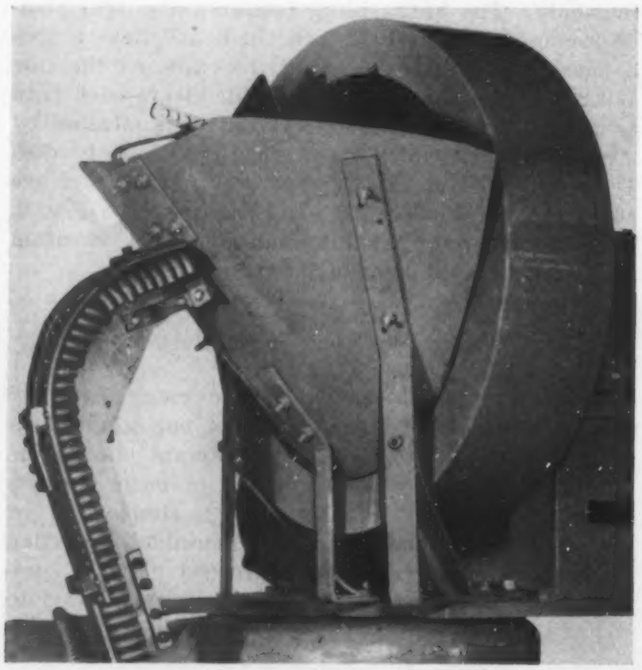
Though with most hoppering methods, each part presents its own problems and dictates designs of considerable variety, there is no basic method capable of so many variations as this one. In its simplest form it may be found in bottling or canning plants, starting containers along conveyor lines. In its most complex form it may be an intricate maze of conveyors, drives, chutes, and sorting devices. *Fig.* 7 illustrates one modification that may be of general interest. The recirculating means is a simple drum with internal buckets driven at constant speed by a reducer and the parts are made to straddle a formed rail.

The simple hopper, *Fig.* 7, is shown in line diagram in *Fig.* 8. The drum is rotated at a slow uniform rate by a motor reducer drive not shown. The vanes carry the pieces up to wing guides and they slide off along the rail. Some of them straddle the rail and continue out of the hopper. The others fall clear and are deflected by the stationary shield back to the drum. If pieces are not used from the rail, they back up to the wings and sufficient clearance must be allowed for the vanes to clear the pile of parts and dislodge the excess. When parts are again being used, the pile on the wings empties and normal selection resumes.

As was mentioned in the foregoing, while the hopper shown is very simple, all hoppers of this type require development, as the action of workpieces tumbling freely is quite different than when they are restrained to travel in certain selected paths. The designer is urged to improvise quite accurate mockups of contemplated design before attempting to have the unit built.

Design Affects Chuting Possibilities

In general, if a part has stability of physical outline, has reasonable uniformity and has pronounced shape characteristics where orientation is required, there is usually some practical method of hoppering. Pieces having thin sections or edges, heat-treated pieces subject to warpage or pieces which interlock or tangle badly, present special problems but are not necessarily impossible to handle. A designer is usually wise in first studying the chuting possibilities of the piece. For example, a socket head set screw becomes almost impossible to handle when its length and diameter are about equal, because it tends to rotate and bind or lose orientation in the chute. As a rule, if a piece can be handled in a chute without binding, it is an excellent prospect for automatic hopper feeding. Speed in assembly of mass-produced machines or mechanisms can thus be assured.



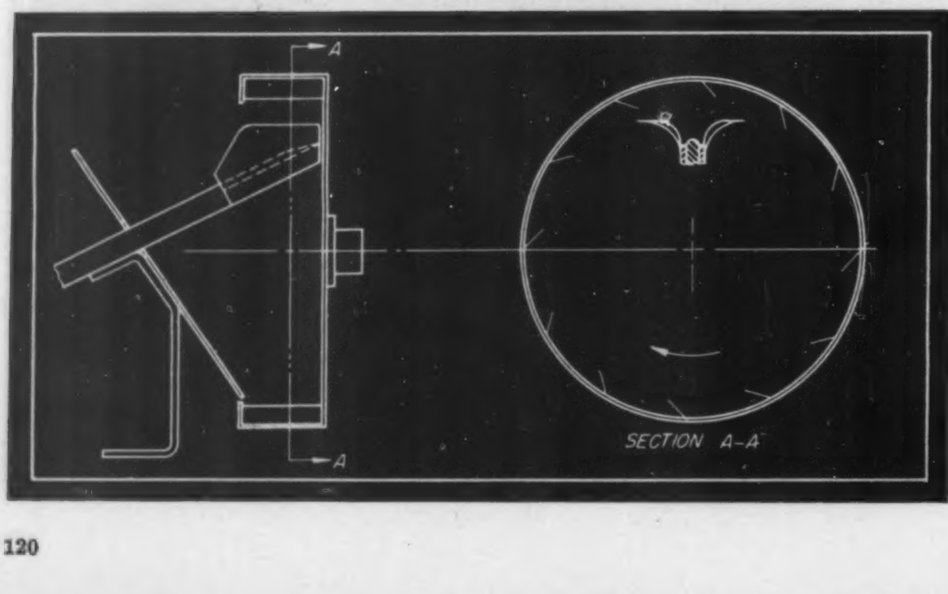


Fig. 7—Left Above—Recirculating type hopper design in which a drum with internal buckets deposits parts straddling the exit feeder rail

Fig. 8 — Left — Cross section through a recirculating type hopper showing the internal buckets and feeder rail

Superprecision Ball Bearings

By Thomas E. Rounds
Chief Engineer
The Barden Corp.
Danbury, Conn.

Part IV—Shaft, Housing and Enclosure Design

IN SUPERPRECISION bearing mountings, the shaft should be designed with ample factors of stiffness if best performance from any bearing is to be expected. Conventional bearings of the various rigid types discussed in this article cannot be expected to be subject to errors of alignment arising from shaft deflection appreciably greater than the allowable errors in the bearings themselves.

SHAFT DESIGN: Most precision bearings are "face mounted" or, in other words, take their alingment from the shaft shoulder and locking device rather than from the cylindrical journal surface. This is due to two factors, namely; the low ratio of bearing width to bore diameter, and the type of mounting fit used.

Excessive shaft deflection obviously causes a "wobbly" running action of the balls in the loaded zone under pure radial loading, and with combined radial and thrust or pure thrust loading conditions are made more critical. In the case of superprecision bearings where parallelism of groove to face is held to limits of 0.0002-inch or less, it is, of course, desirable that errors of the same magnitude due to shaft deflection and other misalignments should not be exceeded. In other words, the misalignment at the bearing should not exceed the specified permissible errors of parallelism between grooves and faces of the bearing races. Possible causes of inner ring misalignment are shown in exagerated form in *Fig.* 23.

The lower the errors of inner ring alignment, the less will be the heating and the longer will be the bearing life. This is particularly true in the case of bearings running at high speed. Bearings under pure radial loading, running with positive internal clearance, will develop less distress under shaft deflection than will bearings running under end thrust or constrained tightly in duplex preloaded mountings. In end-thrust loaded applications, the alternate speeding and slowing of the balls due to their being forced to roll at different radii from the axes of rotation will develop heavy rubbing action on the retainer pockets and frequently be the cause of severe heating and rapid failure of the ball retainer.

Suffice it, then, to say that the mounting of the inner ring on its shaft seating is very important. The shoulder should be ground (and lapped in the case of extremely high-speed applications) square with the journal seating surface. In doubtful cases the flatness of the shoulder should be checked with a lapped ring gage to assure maximum contact with the inner ring face.

The maximum shaft fillet radius specified for

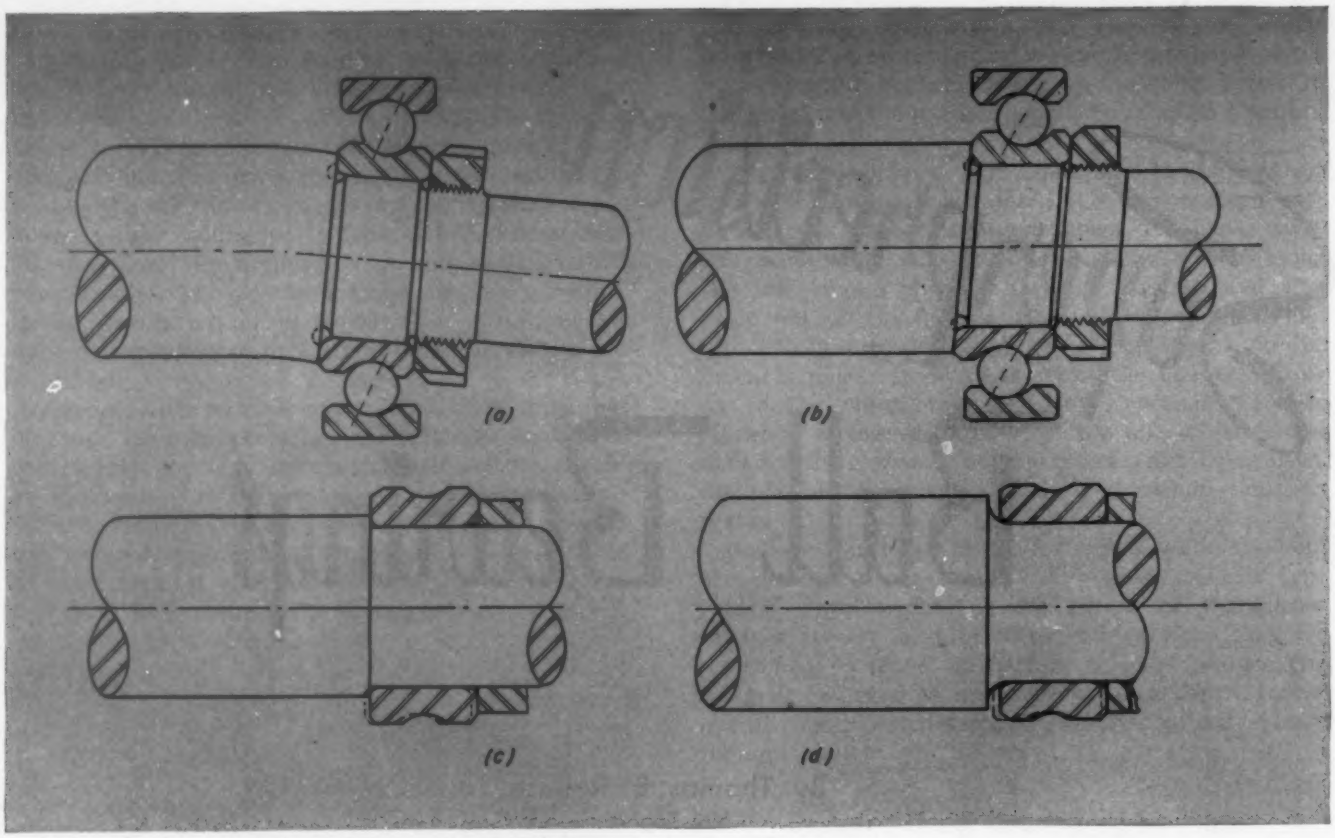


Fig. 23—Various causes of rotating inner ring misalignment. Exessive shaft deflection condition is shown somewhat exaggerated at (a), out-of-square shoulder condition at (b), insufficient shoulder condition at (c), and oversize shaft fillet condition at (d)

standard bearings should never be exceeded and it is excellent practice to use an angling undercut so that the shoulder may be ground flat and square. Grinding wheel breakdown is minimized by the undercut. The undercut should be ground and polished if stresses are high, in order to avoid stress concentration. However, if stresses are high, generally the deflection angles also will be high, a condition which should be avoided at all cost.

In the cases where loads are heavy and a press fitting is required, the shaft must be given attention for absence of chatter waves, out of roundness and taper. Minute irregularities occasioned by such errors are reflected into the raceway groove, giving rise to

Fig. 24—Below—A typical arrangement showing tandem-matched pairs of bearings on a high-speed spindle with a multiple type coil spring adjustment

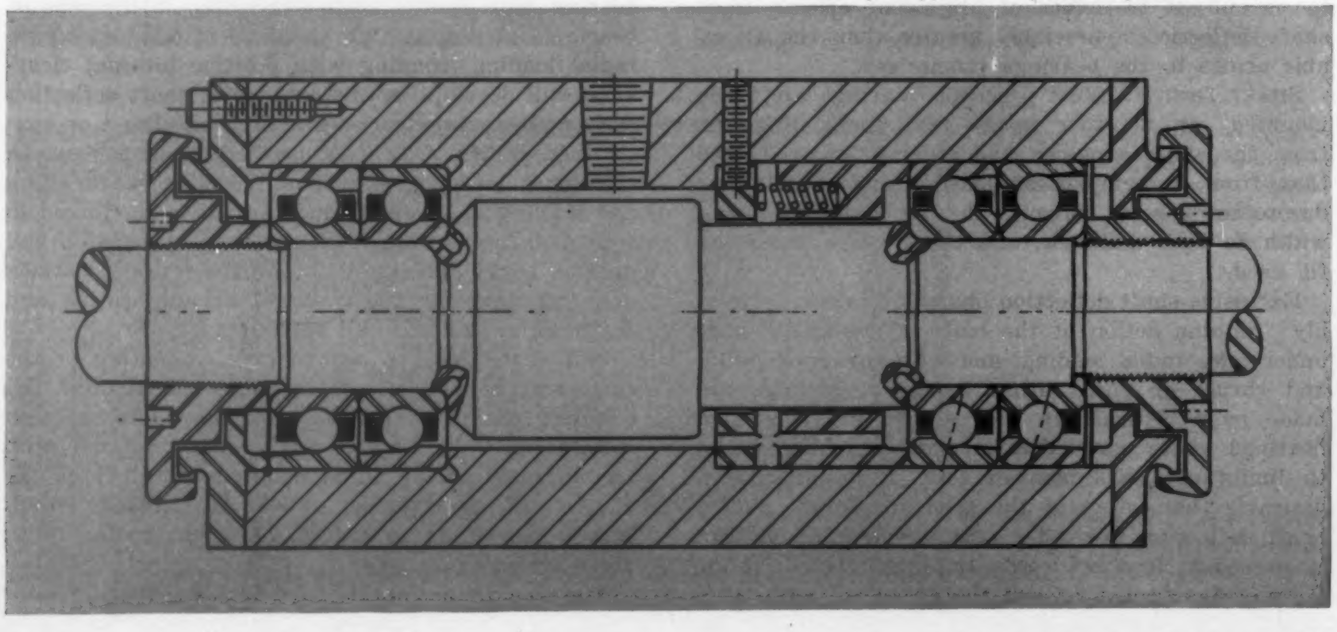
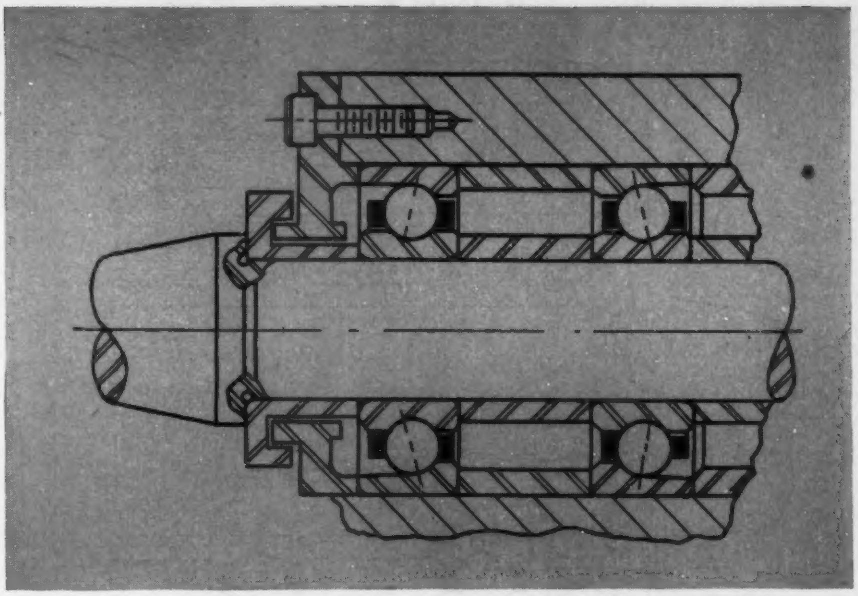


Fig. 25—Right—A labyrinth sealing arrangement in its simplest form



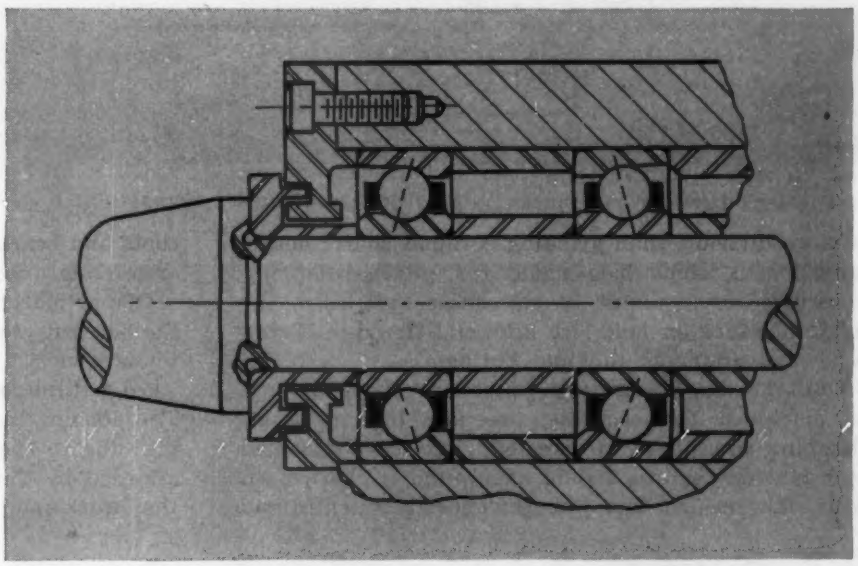
rough and uneven running as well as noise and vibration, which cannot be tolerated on precise spindle work.

In some cases, on extremely precise spindle work the shaft locknut threads are ground and locknut faces are ground square with threads after threading locknuts on a ground threaded arbor. In any case, it is wise to use a free fitting thread on the shaft.

Ball bearing type lockwashers may be ground flat and parallel before bending the prongs but lead washers and washers made of soft pliable gasket material provide a valuable expedient to avoid camming or bending of the shaft. The above comments are particularly true on long slender shafts; large-diameter shafts of short length are much less critical as to bending due to locknut errors.

One expedient of considerable value where shafts are dead-ended

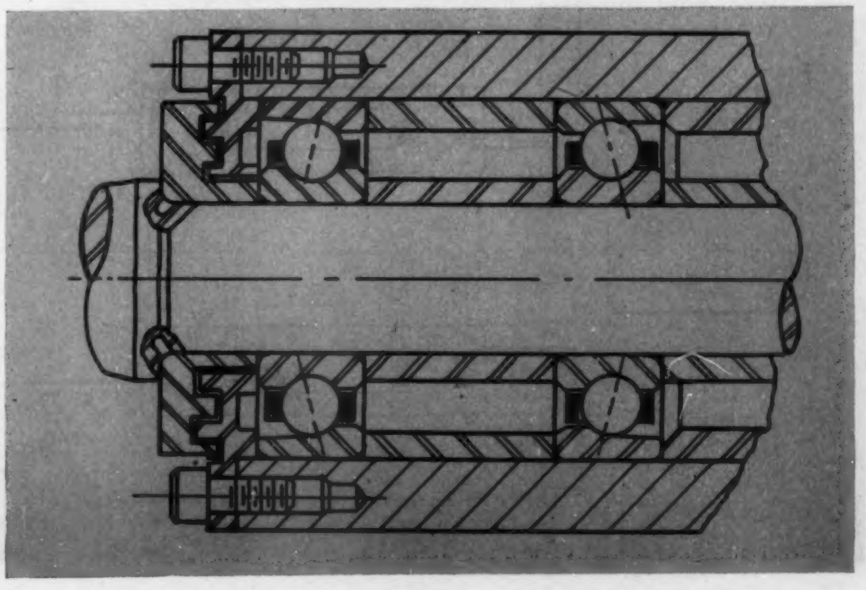
Fig. 26—Right—The labyrinth seal utilizing a single grooved member



is to use a locking ring having a single screw of small diameter at the shaft center where bending reactions will be confined largely to the screw itself. In cases where spindle shaft extensions or shafts between bearings do bend due to locknut threads, the locknut faces may be scraped to compensate until bending of the shaft is minimized.

Housing Design: The requirements for housings are similar to those which apply to shafts in precision work. The housing should be rigid, well supported and stable against distortions arising from the radial and axial loadings and from distortions arising from attachment to the machine frame. Good alignment is most important, as in the case of shafts, to avoid serious stresses being imposed on the ball retainers on high-speed applications. Boring a round housing seat

Fig. 27—Below—A labyrinth seal with double grooves for bad conditions



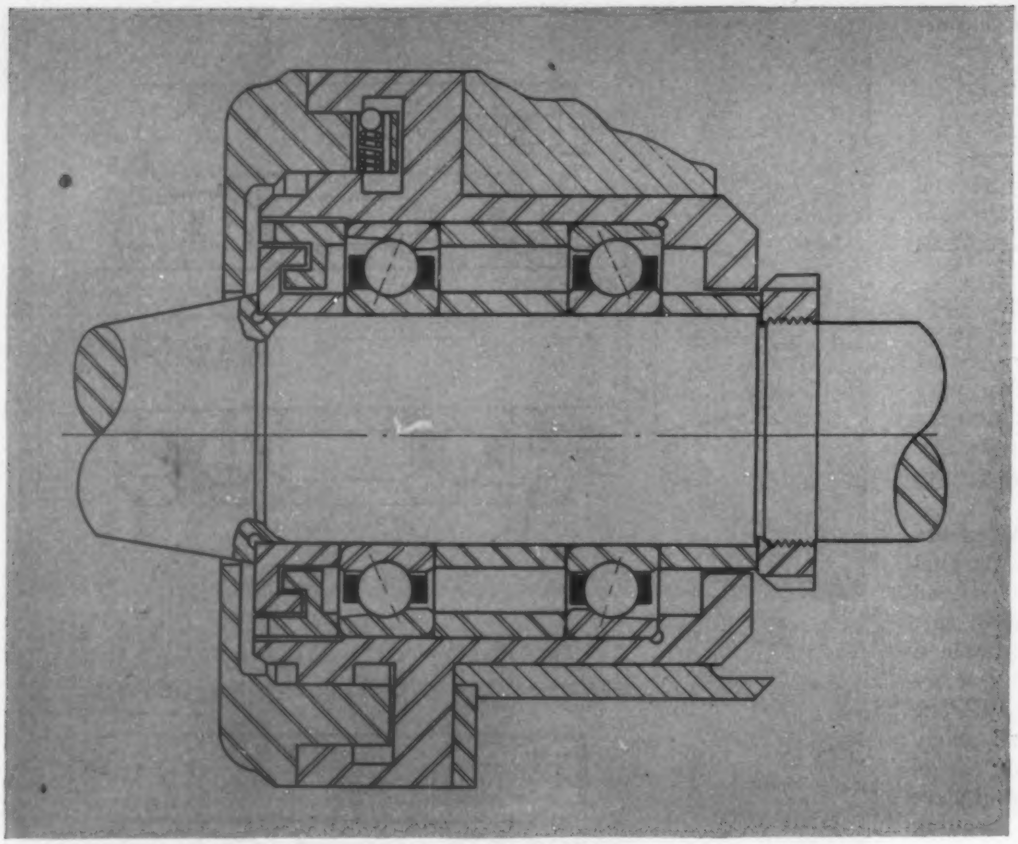


Fig. 28 — Left — Where conditions are particularly severe, the labyrinth with single groove and supplementary shroud can be used

is more difficult than grinding a round shaft; hence, provision is sometimes made for internal lapping to reduce errors of out of roundness well below the total tolerance on hole size allowed. Through boring is always preferred to blind boring.

Quill housing mountings which are clamped must be machined for accurate size and fitting before clamping pressures are exerted. End caps fastened with machine screws should have pitch circles chosen with allowance for generous thickness between thread roots and bearing bores to avoid distortions that may arise from unequal tightening of cap screws or bolts.

Of particular importance on high-speed spindles is the necessity that the "floating bearing" really floats. Usually most of the heat generated is dissipated outwardly through the bearing outer ring to the housing. The housing member usually is cooler than the bearing, due to the ample heat radiation and conduction afforded by the machine mass. In most applications, the work-end bearing, or bearing pair, is locked

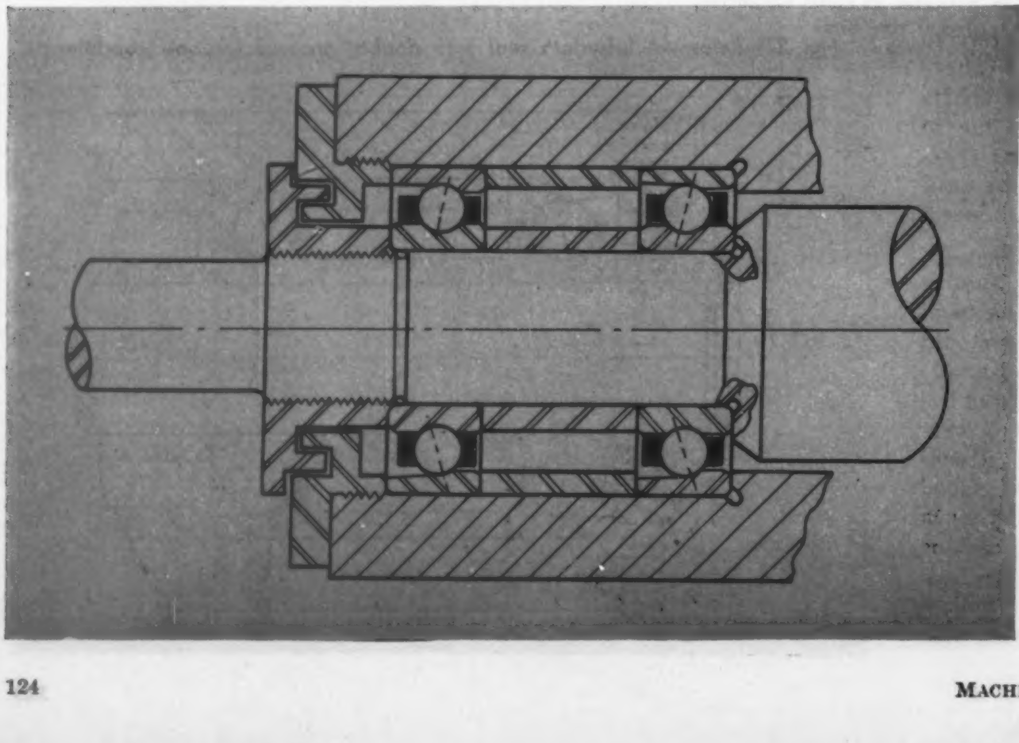
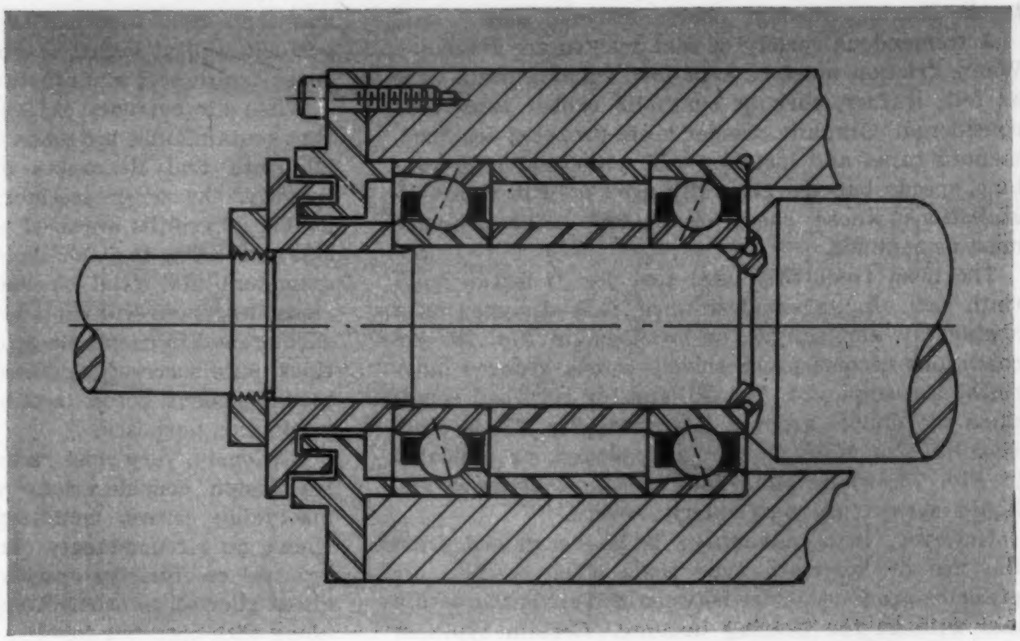


Fig. 29—Left—Combination locknut and labyrinth seal collar unit construction such as this should be avoided because of difficulty in holding close clearances in the seal units

Fig. 30 — Right — Preferred design for labyrinth seals which provides for precision fits of the sealing elements



rigidly against the spindle and housing shoulders with the opposite-end bearing or bearing pair being allowed to float, or spring loaded for automatic takeup of bearing looseness. If this "floating" bearing cannot move axially in the housing, extremely heavy thrust loads will be developed which will, in turn, further increase the heating in a vicious cycle, which may soon result in bearing destruction. In some cases where cool air currents pass over housings, extra allowance for bearing looseness in the housing must be made. The same comments apply for spring adjusted bearing mountings.

Briefly, there was mentioned the use of spring adjustment for spindle bearings. Single or double-bearing arrangements are generally used for high speed. In all cases, the spring system chosen should have a high deflection or low stiffness rate so that minor changes in spindle length in relation to the housing will not appreciably change the bearing preload. In any case, the springs should be "softer" than the bearing, should be ground to equal lengths and should be well aligned so that cocking of the bearing ring will not occur. Long piloted spring seats or follower cups are recommended practice. A typical arrangement is shown in *Fig.* 24.

ENCLOSURE DESIGN: The exclusion of foreign matter from the bearings is the factor which in nearly 90 per cent of all cases determines the success or failure of an installation regardless of speed or load imposed. Consistent accuracy and proper performance over any period of time cannot be expected if dirt, grit, grinding dust or foreign particles of any nature are allowed free access

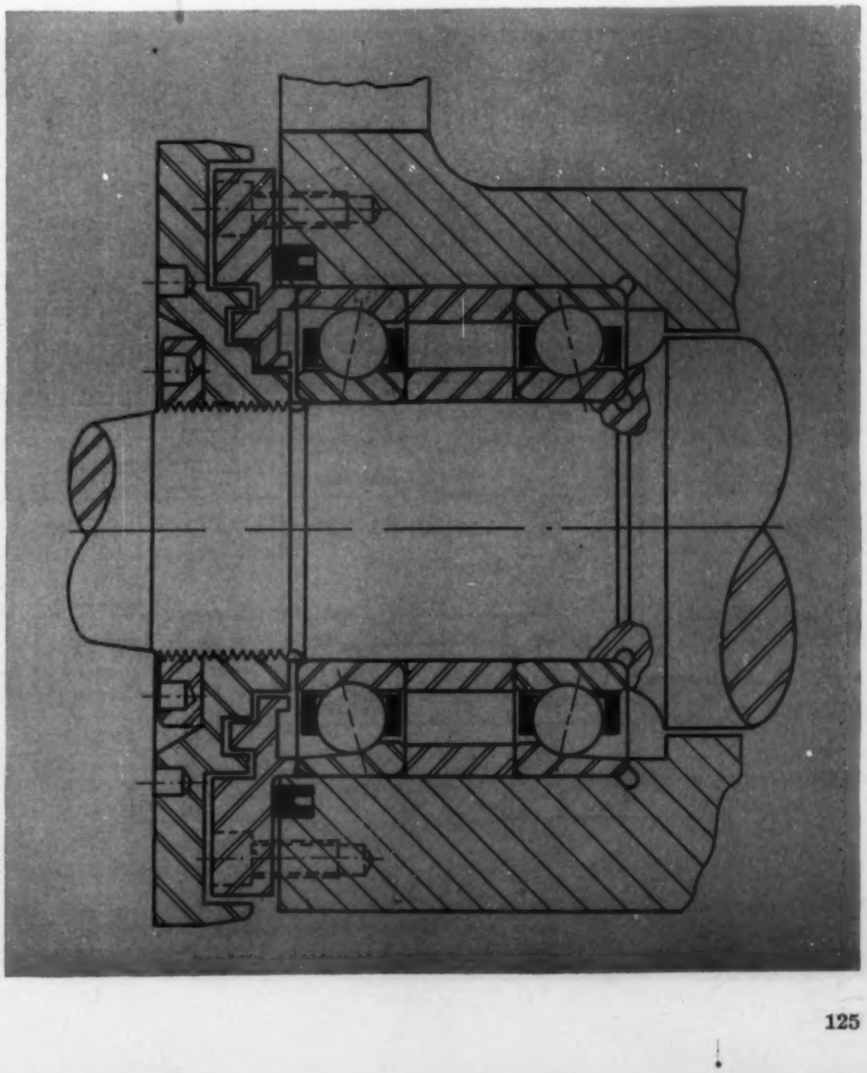


Fig. 31 — Right — Housing design in which a Neoprene synthetic rubber packing ring is utilized to make the housing oil tight

to the bearings through poorly designed seals.

A tremendous variety of seal designs are available. Where friction must be kept low, rubbing seals such as felt, leather, cork or synthetic rubber cannot be considered. Graphite washer seals properly designed, manufactured and installed will withstand high rubbing speeds but are generally used only in those installations where gases or liquids under pressure must be retained.

The most frequently used seal design is the labyrinth seal. In its simplest form, it is designed as a simple cap and slinger, as is shown in *Fig.* 25. As conditions become progressively worse, grooved labyrinths are employed, *Fig.* 26, and for very bad conditions the double grooved labyrinth, *Fig.* 27, is used. Sometimes a shroud piece is employed, as indicated in *Fig.* 28, where conditions of chips, abrasive and liquid sprays are particularly severe.

However, little advantage is to be gained from the use of labyrinth type seals when definite air pressure gradients exist between the air space within and without the bearing housing. Certain types of grinding spindles tend to operate with air pressure within the spindle housing lower than the outside atmospheric pressure. In such cases, dust or foreign matter must be prevented from entering the bearing housings either by means of rubbing seals or by applying internal pressure from carefully filtered air lines. Generally, the speeds of rubbing seals of leather, cork and similar materials are limited to somewhat less than 2000 feet per minute. Certain types will perform well at higher speeds and users are urged to consult with seal manufacturers on specific problems.

When air currents or pressure gradients are such that contaminable air tends to enter bearing housings, labyrinth seal clearances must be kept quite close radially. On one grease lubricated high-speed spindle, double labyrinths are used with radial clearance (per side) of 0.001 to 0.002-inch (0.002 to 0.004-inch on diameter) and axial clearances of 0.015-inch. Such close clearances will exclude the bulk of abrasive dust encountered in deep-hole grinding and similar applications quite successfully. Users, however, are cautioned to experiment before setting final seal designs for production purposes.

Obviously, very close radial clearances dictate careful design considerations with regard to expected machining errors, mounting fits and eccentricities. Under no circumstances can errors of total run-out or total eccentricity exceed the diametral seal clearances allowed as otherwise serious rubbing will occur along with high friction and wear.

Frequently it is desired to combine a locknut and a labyrinth seal collar in one piece and to thread the housing cap into place in the housing as in *Fig.* 29. Wherever possible, this construction should be avoided, since it is practically impossible to hold close radial seal clearances with the eccentricities resulting from the threaded members. The arrange-

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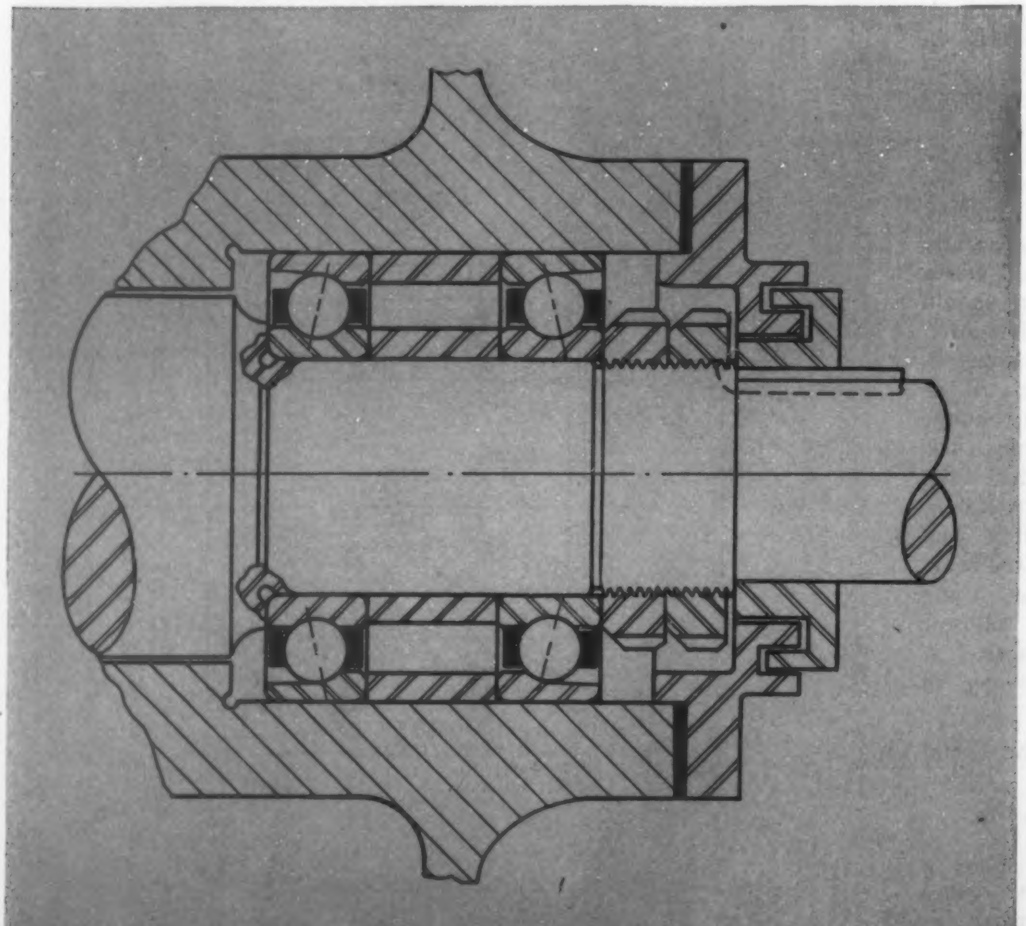


Fig. 32 — Housing cap for the floating end of the spindle bearing arrangement may be simply sealed by means of a flat gasket

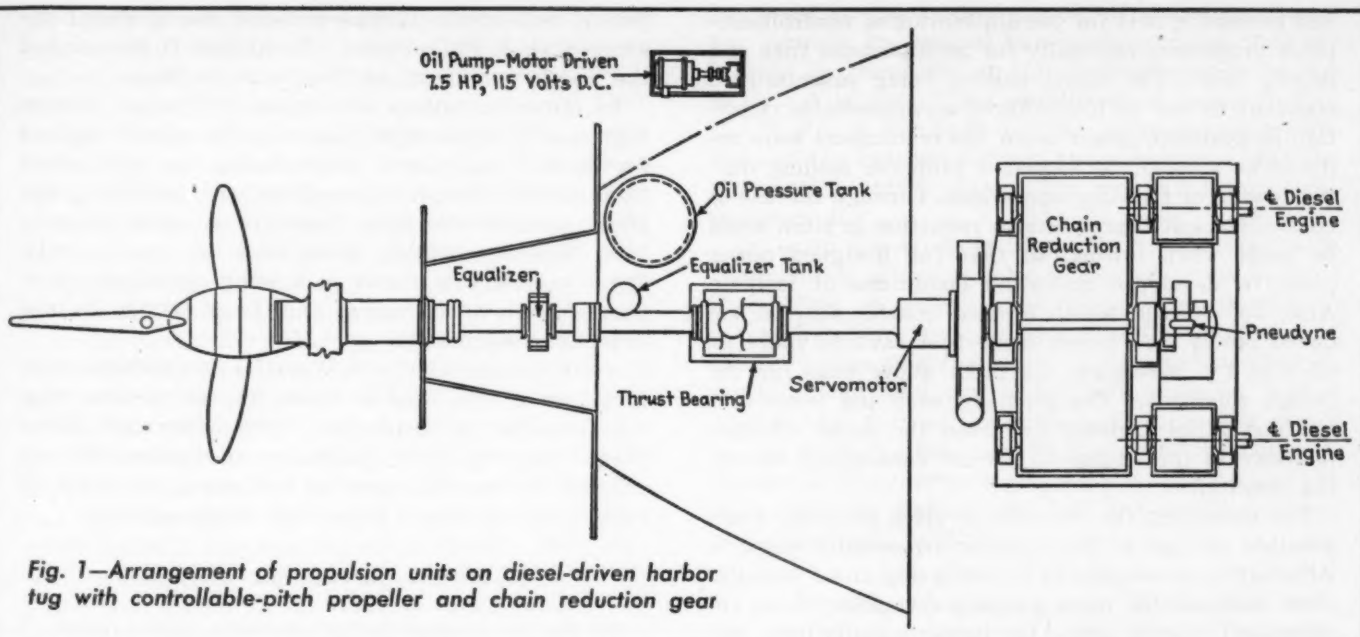


Fig. 1—Arrangement of propulsion units on diesel-driven harbor tug with controllable-pitch propeller and chain reduction gear

Applying Pitch-Changing Mechanisms to Marine Propellers

By Lewis A. Rupp
Commander, U.S.N.
Bureau of Ships
Navy Department
Washington, D. C.

CONTROLLABLE-PITCH PROPELLERS, an essential component of high-performance aircraft, have undergone a less widespread but highly significant development for marine uses. Eventual application of gas turbines to marine propulsion will open up a big field for this type of propeller. This article, which is based on an extensive paper presented at the recent annual meeting of the Society of Naval Architects and Marine Engineers, outlines recent developments and illustrates current designs

INVENTIONS molder and become forgotten remnants of time if the need is removed or is diminished sufficiently, and are reborn only when some new need arises. In the early nineteenth century, after steam was first applied to ship propulsion and the screw propeller was an infant, sails were still required to augment the power of the crude low-powered steam engines and to provide emergency propulsion in case of the frequent engine failures. However, favorable or adverse winds affected the revolutions of the screw, sometimes causing overspeeding of the engine in the case of a sudden squall. Therefore it was considered desirable to vary the pitch to suit these conditions, as well as to feather the propeller blades in line with the keel when operating with sails only.

When sails were discarded from commercial and naval vessels, the controllable-pitch mechanisms of the early and middle nineteenth century—crude prototypes of some later, more successful devices—were relegated temporarily to the past.

Use of diesel engines for marine prime movers offered a new

and promising field for the application of controllable-pitch propellers, especially for multipurpose tugs and fishing craft. The diesel engine, being essentially a constant torque device, suffered an appreciable reduction in available power when the revolutions were reduced as a result of increased propeller loading during towing or trawling operations. Through the use of controllable-pitch propellers a reduction in pitch could be made when towing, so that full designed power could be developed under all conditions of loading. Also, for vessels which cruised considerably at reduced power and speed, some fuel savings could be effected by increasing the pitch above that for the design condition. The pitch increase and lower revolutions while cruising increased the mean effective pressure in the engine to a more economical operating condition.

For reversing, the controllable-pitch propeller made possible the use of the simplest irreversible engines. Alternative developments for reversing diesel installations included the more complex reversible diesel engines and electric drive for larger installations, and mechanical reverse gears for small craft.

Since reliability and sound engineering are based on simplicity, the marine industry was slow in replacing the vital and vulnerably located fixed propeller, having its simple shaft attachment, with the more complicated mechanism of the controllable-pitch propeller, in spite of its advantages for certain diesel applications. Reliability is established only by a slow evolution, and the history of some of the earlier, poorly engineered controllable-pitch mechanisms offered no great impetus to accelerate further development.

The fact that some controllable-pitch mechanisms have proved their reliability has caused designers to seek further improved mechanisms and to review the potentialities of controllable-pitch applications with present-day, as well as future, prime movers. To this end the United States Navy fitted an experimental controllable-pitch propeller on a small 250-horsepower diesel tug in 1940. The following year the most powerful controllable-pitch propellers yet constructed were installed in the 28,000-shaft-horsepower, twin-screw, turbine-powered World War I destroyer, *U. S. S. Dahlgren*. World War II interrupted the proper evaluation of these installations.

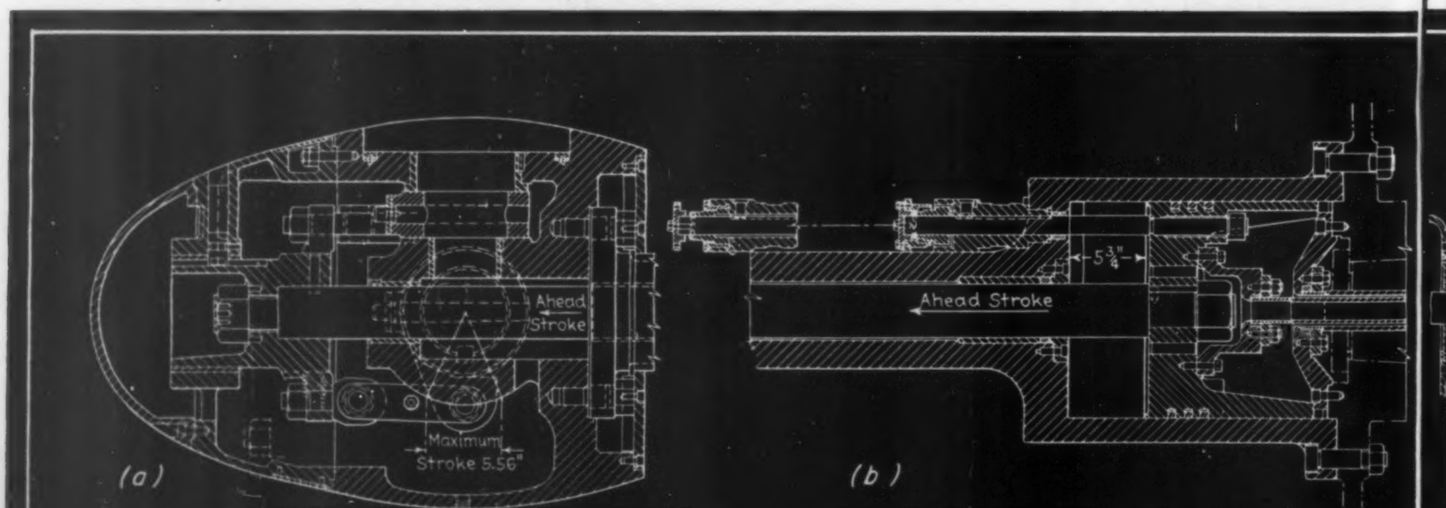
In order to utilize two types of General Motors high-speed, lightweight, nonreversible diesel engines for landing and patrol craft during the war, about 2400 controllable-pitch propellers, each absorbing 900 shaft horsepower, were installed in approximately 1100 infantry landing craft and 100 patrol craft. These vessels saw action in landing operations from Guadalcanal to Okinawa, and from Africa to the beaches of Normandy.

After the end of World War II a controllable-pitch propeller of the Escher Wyss Kaplan turbine type was installed in a 100-foot, 1000-horsepower Navy harbor tug, *Fig.* 1. Thus, finally, an opportunity was afforded to conduct careful and complete trials to evaluate performance and obtain design criteria.

Hydraulic Servomotor Utilized

In the successful Kaplan turbine applications, a control rod inside the shaft was actuated by a hydraulic servomotor. In marine applications where the end of the shaft is inaccessible for the admission of the hydraulic oil connections to the servomotor, a stationary oil distribution box and control valve is mounted on the shaft, with high-pressure packing at each end of the distribution box. An oil pressure tank, supplied by an oil pump which operates intermittently to maintain the designed pressure head, furnishes high-pressure oil through the control valve and oil distribution box to the hydraulic servomotor. The control valve can be operated either manually, or by electric, or sometimes pneumatic, means. The hub cavities are filled with oil to provide lubrication for the bearings, cranks, and crosshead. In order to apply a small positive differential head to the lubricating oil for the prevention of possible ingress of water through the blade seals, an additional oil pressure equalizer tank, located above the waterline, is provided.

Controllable-pitch mechanisms of the type described, with pressure distribution boxes mounted on



the shafting, were designed and built by the S. Morgan Smith Company and installed in the *Dahlgren* and in the U. S. Maritime Commission vessel *Single Hitch,* a small diesel-powered cargo vessel, in 1945. During the period of the *Dahlgren* trials, the only difficulties encountered with the mechanism design were centered at the distribution box, where some shaft wear was encountered, along with excessive leakage and packing difficulties. It was considered that deeper stuffing boxes in a future design would correct the difficulty.

In the *Single Hitch* the mechanism difficulties encountered were few and, for the most part, cannot be attributed to the propeller. After eighteen months of service the distributor box, which was made from a porous casting, allowed cooling water to pass into the hydraulic oil system. The distributor cooling medium was then changed to oil to safeguard against future water leaks. Finally, the shaft at the distributor box became scored, primarily because the propeller was locked in a fixed position during one entire voyage without adequate lubrication at the distributor. Leakage between the lubricating and hydraulic oil resulted, and it was necessary to change to a single oil system for both pitch-changing and lubrication. A piping alteration also was made to prevent overflowing the lubricating-oil gravity tank and to reduce the hub lubricating-oil pressure.

Oil Distribution Box Difficulties

From the operational experience of these two vessels, it is considered that the pitch-changing mechanism is satisfactory and reliable, with the exception of the oil distribution box which at best presents a difficult problem of maintaining alignment and preventing shaft wear and overheating when the ship is working in a seaway. Therefore, whenever the forward end of the shaft is accessible, the hydraulic control mechanism should be located there, in lieu of using a distribution box.

A similar controllable-pitch mechanism was installed in the U. S. Navy tug *YTB*502 in 1946. In this application the forward shaft end was accessible for inserting the high-pressure oil connections and for locating the control valve arrangement, thus obviating the need for an oil distribution box on the shaft. A layout of the installation is shown in *Fig.* 1. In *Fig.* 2 are indicated the cross-section assemblies of the hub mechanism, the servomotor, and the pneumatic control system for regulating the high-pressure oil.

In early trials, difficulties were encountered with the pumping action of the control rod, which resulted in building up either excessive pressure or vacuum in the hub, depending on the direction of motion of the pitch-changing operation. This was corrected by replacing the solid control rod with a smaller hollow one, so that the hub lubrication oil could flow freely to and from the hub cavities during pitch changing. Following this alteration and the strengthening of the connecting rod links in the hub, the installation has performed very reliably.

Provision for Emergency Operation

Since most hydraulic pitch control mechanisms are not self-locking and require constant pressure on the servomotor, means must be provided for emergency operation in case of failure of the hydraulic system. In the *YTB*502 mechanism shown in *Figs.* 1 and 2, the servomotor piston can be positioned by a hand-operated pump and locked to the servomotor cylinder by means of locking rods. Operators report its performance superior to that of reversing diesel, and diesel-electric drives.

Principles of the General Motors electro-mechanical pitch-changing device are illustrated in *Fig.* 3. This device, developed in further detail, was installed in some 1200 landing and patrol craft during World

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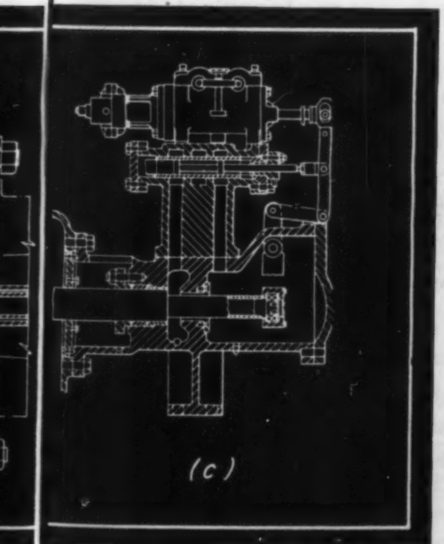


Fig. 2—Left—Cross sections through (a) the hub mechanism with its crosshead and crank levers for rotating the blades, (b) the hydraulic servomotor for producing axial motion of the control rod inside the shaft, and (c) the Westinghouse Pneudyne control

Fig. 3—Right—General Motors controllable-pitch propeller, showing (a) the control mechanism; (b) the overlapping skewed spindles and the nesting of the helically threaded spindles with the rack on the control rod; and (c) a longitudinal elevation

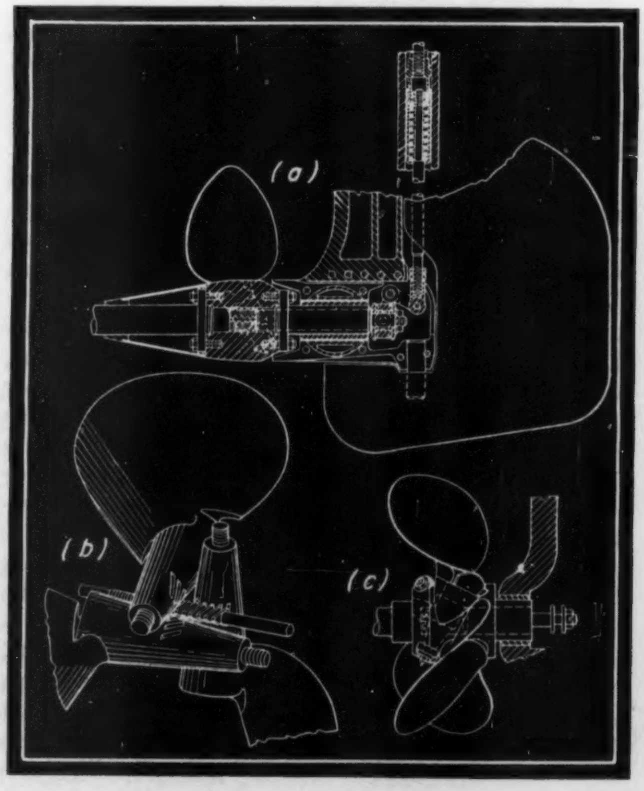
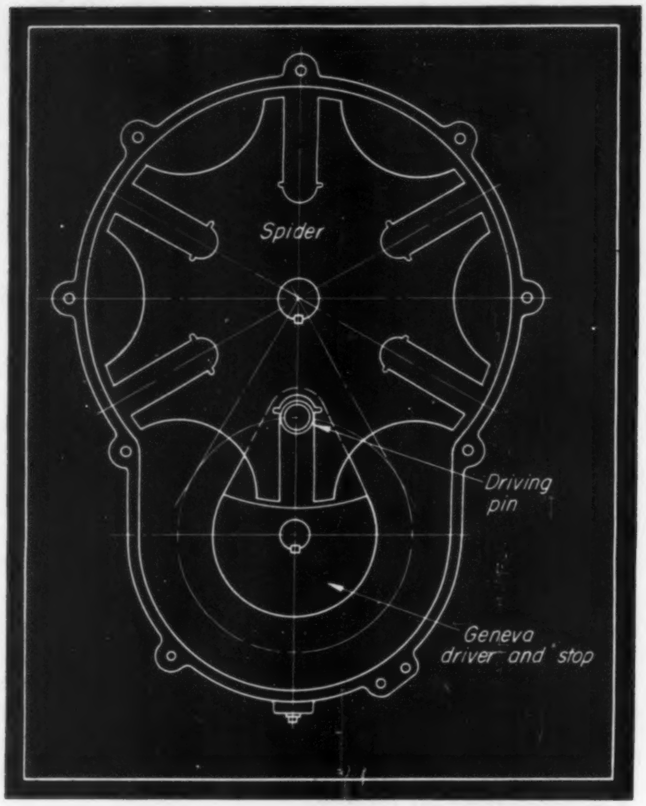


Fig. 1—Typical six-station geneva drive mechanism. Intermittent motion of the spider causes high accelerations and inertia stresses in driving and driven elements



Calculating Acceleration in Geneva Drives

By Paul H. Winter
Supervisor of Machine Design and Process Engineering
Pass & Seymour Inc.
Syracuse, N. Y.

ONE of the most commonly used indexing mechanisms in automatic machinery is the geneva drive, *Fig.* 1. A method is presented here that makes it possible to calculate accurately the dimensions of all stressed members of this drive by establishing the maximum angular acceleration of the indexed member; if the moments of inertia of the rotating parts are known the maximum torque can be established since torque = angular acceleration × moment of inertia.

Referring to *Fig.* 2, which represents the geometry of a geneva drive of any number of index stations, the requirements are: (*a*) The driving member or rotor, represented by *AB*, must enter and leave the slots of the driven member or spider, represented by *CB*, tangentially, so that angle *ABC* is a right angle; (*b*) Rotor *AB* must rotate at a uniform angular velocity ω_o.

Angle α is determined by the number of index stations. Since angle *ACB* represents one-half the angle indexed through by the spider, $\alpha = 180° - (360°/2 \times \text{number of index stations}) - 90° = 90° - (180°/n)$ where n = number of index stations. For any position of the mechanism in engagement let θ be the angular displacement of the rotor from the common center line and let β be the displacement of the spider from the common center line. Since the rotor moves with constant angular velocity the only angular acceleration occurs in the spider and it is therefore required to find the second derivative of β with respect to time in terms of known quantities.

Since *AC* in the triangle *ABC* is $R/\cos\alpha$, and since sides $R/\cos\alpha$, R, and the angle θ in the triangle *ADC* are known:

$$\tan\beta = \frac{\sin\theta\cos\alpha}{1 - \cos\theta\cos\alpha}$$

$$\beta = \tan^{-1}\left(\frac{\sin\theta\cos\alpha}{1 - \cos\theta\cos\alpha}\right)$$

Differentiating this equation with respect to time t,

$$\frac{d\beta}{dt} = \frac{d\theta}{dt} \times \frac{d\beta}{d\theta}$$

$$= \omega_o \frac{d\left(\tan^{-1}\dfrac{\sin\theta\cos\alpha}{1 - \cos\theta\cos\alpha}\right)}{d\theta}$$

which on differentiation becomes

$$\omega = \frac{\omega_0 \cos\alpha\,(\cos\theta - \cos\alpha)}{1 - 2\cos\alpha\cos\theta + \cos^2\alpha}$$

where ω is the angular velocity of the spider.

Angular acceleration $= d^2\beta/dt^2 = d\omega/dt$, therefore

$$\frac{d\omega}{dt} = \frac{d\theta}{dt} \times \frac{d\omega}{d\theta}$$

$$= \frac{\omega_0^2 \cos\alpha\,(\cos^2\alpha - 1)\sin\theta}{(1 - 2\cos\alpha\cos\theta + \cos^2\alpha)^2}$$

which is the angular acceleration of the spider for any angle θ.

To find when this acceleration is a maximum it is necessary to differentiate the value of the acceleration and equate the result to zero. Carrying out this differentiation,

$$\cos\theta - 2\cos\alpha\cos^2\theta + \cos^2\alpha\cos\theta - 4\cos\alpha\sin^2\theta = 0$$

from which

$$\cos\theta = \frac{-\cos^2\alpha - 1 + \sqrt{\cos^4\alpha + 34\cos^2\alpha + 1}}{4\cos\alpha}$$

which is the value of θ which produces the maximum acceleration.

TABLE I shows the values of α, θ at maximum acceleration, and maximum acceleration for different numbers of index stations.

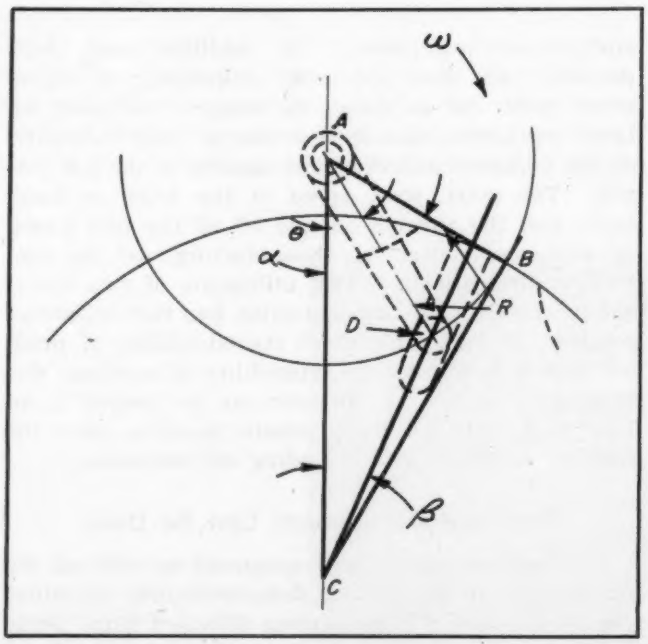


Fig. 2—Geometry of the geneva drive mechanism for any number of index stations

EXAMPLE: Find the diameter of the index table shaft and the driving pin for a six-station geneva drive, *Fig.* 1, the index table to be 15 in. diameter, 1½ in. thick and to index 40 times a minute.

The rotor makes one revolution in 1½ seconds so $\omega_0 = 2\pi/1.5 = 4.18$ radians per second. From TABLE I, maximum acceleration of index table $= 1.35 \times 4.18^2 = 23.7$ radians per second per second.

TABLE I.
Maximum Acceleration Factors for Geneva Drives

Number of Stations (n)	$\alpha =$ 90° − (180/n)	θ at max. acceleration	Maximum acceleration
3	30°	4°46′	$31.5 \times \omega_0^2$
4	45°	11°28′	$5.42 \times \omega_0^2$
6	60°	22°55′	$1.35 \times \omega_0^2$
8	67.5°	31°42′	$0.7 \times \omega_0^2$
12	75°	44° 1′	$0.26 \times \omega_0^2$

A satisfactory diameter for the spider attached to the same shaft as the table and driven directly by the driving pin would be a little less than one-half the diameter of the table, say 7 inches. Thickness of the spider may be assumed to be 1 inch. Moment of inertia calculations are as follows:

Index Table

Volume	$= (\pi/4) \times 15^2 \times 1.5$	= 265 cu in.
Weight	= 0.27 x 265	= 71.5 lb
Mt. of inertia	$= \frac{1}{2}(71.5/32.2)\,(7.5/12)^2$	= 0.44 lb-ft-sec²

Spider, neglecting cutouts

Volume	$= (\pi/4) \times 7^2 \times 1$	= 38.5 cu in.
Weight	= 0.27 x 38.5	= 11 lb
Mt. of inertia	$= \frac{1}{2}(11/32.2)\,(3.5/12)^2$	= 0.015 lb-ft-sec²

Moment of inertia, allowing 20 per cent for attachments to the table, etc., is $1.2 \times 0.44 = 0.528$ lb-ft-sec². Maximum driving torque therefore is $23.7 \times 0.528 = 12.5$ lb-ft $= 150$ lb-in. Using a permissible shear stress of 8000 psi in the main shaft, the smallest diameter of shaft would be $D = \sqrt[3]{150 \times 16/\pi \times 8000} = 0.46$-inch or ½-inch.

To find the corresponding force on the driving pin it is necessary first to determine the distance of the pin from the center of rotation of the table at the position of maximum torque. From TABLE I this occurs when $\theta = 22°55'$. Referring to *Fig.* 2, BC represents the radius of the spider, 3½ inches in this particular case; since angle $ABC = 90°$ and angle $ACB = 30°$, $AB = AD = 3.5 \tan 30° = 2.02$ inches. Also, $AC = 3.5/\cos 30° = 4.04$ inches, so that in triangle ADC,

$$DC = \sqrt{4.04^2 + 2.02^2 - 2 \times 4.04 \times 2.02 \times \cos 22°55'}$$
$$= 2.27 \text{ in.}$$

Mass to be accelerated by the pin includes the spider as well as the table and attachments, and is equal to $0.528 + 0.015 = 0.543$ lb-ft-sec². Maximum driving torque therefore is $23.7 \times 0.543 = 12.85$ lb-ft $= 154$ lb-in., and the force on the pin is $154/2.27 = 68$ lb.

Controlling factor in the design of the pin would be the contact stress between pin and slot. Since surfaces of pin and slot would be polished and there are no notches or other stress raisers, a working shear stress of 12,000 psi may be assumed. From the Hertz equation (see *Kent's Mechanical Engineers' Handbook,* 11th edition, Design and Shop Practice volume, Page 7-49), $S_s = 677\sqrt{P'R}$ or $12{,}000 = 677\sqrt{68/R}$ from which $R = 0.217$-inch and minimum pin diameter $= 0.434$-inch or 7/16-inch.

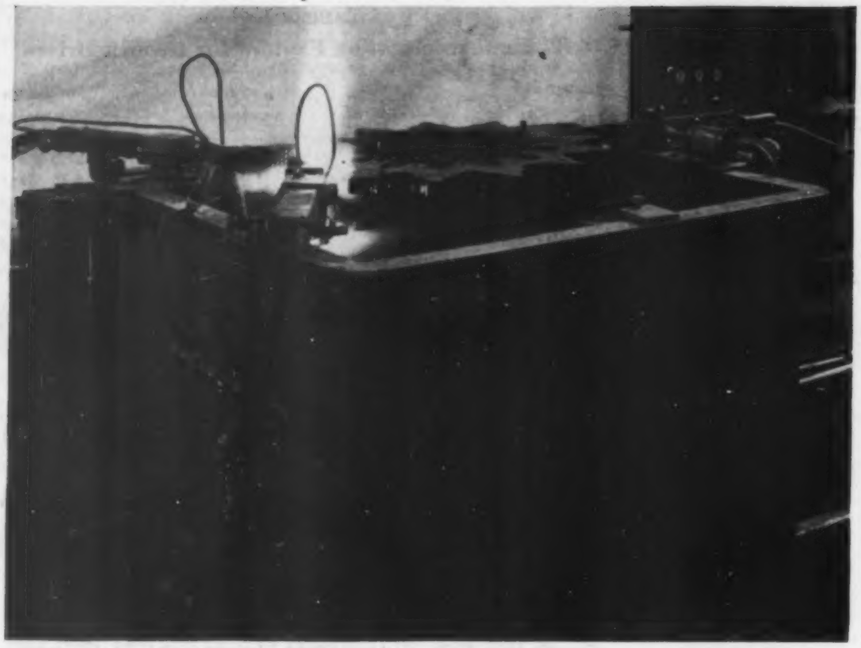


Fig. 1—Sprocket-wheel teeth are flame hardened semiautomatically in this machine which cost less than 500 dollars

Mechanized F

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machines of three ba

By J. R. Burg
The Baldwin Locomotive Works
Eddystone, Pa.

IN CHOOSING a method of surface hardening, many factors, both technical and economic, must be considered. The primary technical factors are degree of hardness and depth of case desired, as well as the size and shape of the piece being hardened. Economically the choice rests on the quantity of parts to be hardened and the facilities available.

Flame hardening is a relatively rapid means of obtaining surface hardness. It consists basically of heating the surface of a hardenable steel or cast iron to above its critical temperature and quenching it in water or air to obtain a martensitic structure of high hardness. It is quick, clean, economical and productive of a variety of results as desired.

Adoption of flame hardening necessitates, in most cases, the use of a higher carbon steel than formerly employed. There is only a small price premium attached to this, however, and the product almost invariably benefits from the use of a stronger material.

Machine flame hardening is accomplished by one of three methods; progressive, spinning or progressive-spinning. Each method has its applications, and one of the methods will be found applicable to almost any surface hardening problem that may exist. Generally speaking, the progressive method is applied to flat surfaces and large, irregular contours; the spinning method to small cylindrical surfaces and the progressive-spinning method to large cylindrical surfaces.

Machinery used for flame hardening should be designed for the specific job, and should not be general-purpose equipment. In addition—and, incidentally, this does not mean elaborately or expensively built, but as simple as complete adequacy allows—equipment should be made as fully automatic as the technical and economic aspects of the job permit. The start, stop, speed of the work or flame head, and the turning on and off of the fuel gases, or any combination of these factors, can be controlled automatically. Full utilization of this inherent potentiality for mechanization has two important results: It makes for exact reproducibility of product and it minimizes the possibility of spoilage due to human error. An operator can be trained in an hour to operate a fully automatic machine, since the task is essentially one of loading and unloading.

Standard Components Can Be Used

The fuel-gas regulating equipment as well as the valves and torches used on flame-hardening machines can be standard. In some cases standard flame heads can be used, but generally it has been found advantageous to design heads specially for the job. Standard flame-hardening heads have been found acceptable for flat surfaces and some cylindrical surfaces, but there are many applications for which they are not adequate.

In choosing a suitable steel the guide is the required surface hardness. In many applications the surface hardness produced by case carburizing is higher than actually necessary, and a realistic survey of the actual requirements will indicate the possibility of reducing surface hardness while still keeping it within practical limits. Experience shows that

From a paper presented at the Twenty-Ninth Annual Meeting of the American Welding Society in Philadelphia.

d Flame Hardening

any advantages — typical
ree basic types described

straight carbon steels in the range of 0.40 to 0.60 per cent carbon flame-harden readily and produce sufficiently hard surfaces for virtually all applications.

Our first venture into flame hardening at Baldwin was in connection with sprocket wheels for medium tanks. These wheels, a familiar sight in all tank arsenals during the war, were flame cut from SAE 4140 steel, and flame hardened to resist wear by the tank tracks. The machine devised for this purpose, illustrated in *Fig.* 1, was similar in principle to many used for this job, but was much simpler in construction than most. Each sprocket tooth was heated by being held stationary between two flame heads for a predetermined interval, after which the sprocket tilted automatically into the water bath over which the apparatus was supported, thus completing the quenching cycle. Pushing down a lever caused the sprocket to index, the next tooth to come up to hardening position, and the torches to light. The entire machine cost less than $500, yet it was almost completely automatic, and compared favorably in volume of production with machines costing many times as much.

Progressive Methods Used on Reverse Link

The steam locomotive reverse link is probably the most universally flame-hardened part of a locomotive. Here, the progressive method is used, *Fig.* 2, the link being supported so the wearing surfaces are horizontal and stationary, and the flame and quenching head, one unit in this case, being driven past the surface by a chain and sprocket arrangement. There are two somewhat unique features of this apparatus. The first concerns the manner of driving the flame head. The head assembly runs on rollers along the edge of the tank, propelled by a sprocket engaging a chain which runs horizontally just below the edge of the tank. This sprocket turns as an idler when the machine is started until a dog on the sprocket engages the chain, at which time the head assembly starts to move and the hardening process begins. By altering this idling period, any desired interval of preheat may be obtained. Consequently, the operator's judgment as to proper preheat does not enter

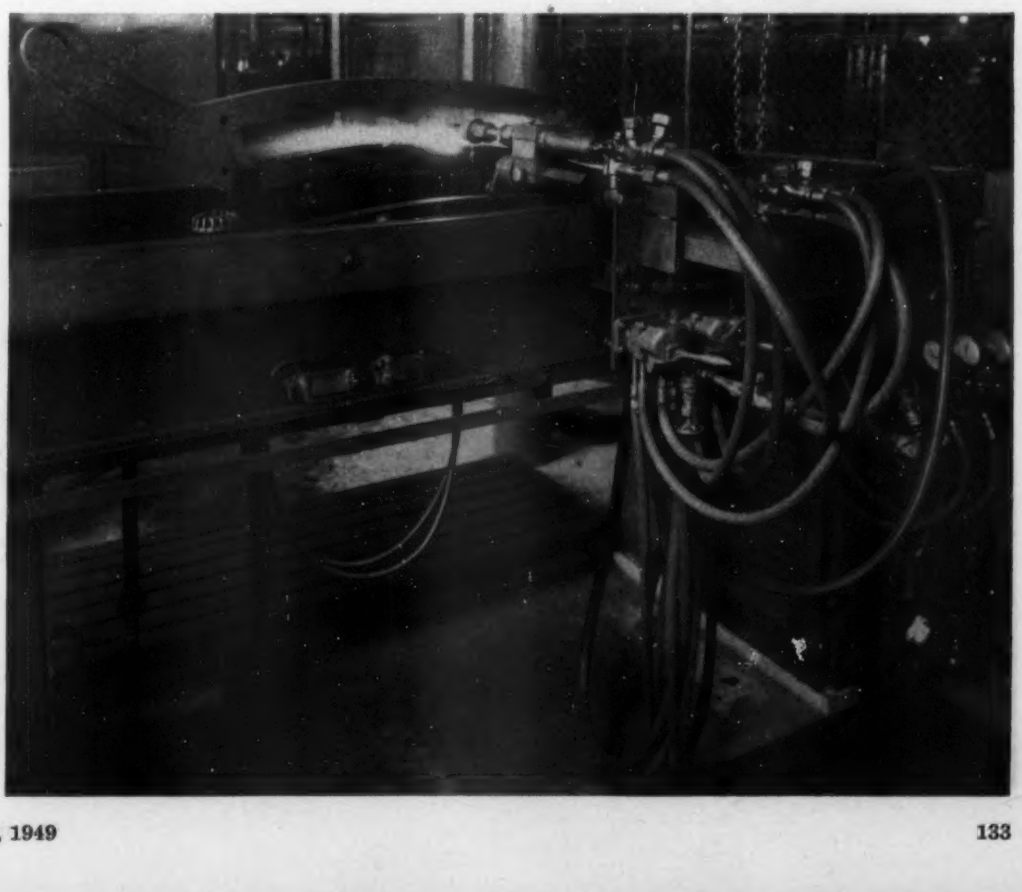


Fig. 2 — Steam-locomotive reverse link being flame hardened in special machine, employing novel sprocket device for varying the preheat

into the process. At the end of travel of the flame head, limit switches cut off the gas supply, the acetylene first—to prevent flashback—and then the oxygen. A static counterbalance automatically returns the machine to the start position and resets the preheat timer.

Template Adjustable to Any Arc

Another feature of this machine is the method of reproducing the arc of the reverse link surface. A strip of spring steel is used, supported horizontally at the center and pulled down into an arc by studs on each end. This strip serves as a template to guide the flame head. Since it is adjustable as to radius of curvature it can reproduce any reverse link arc, or can be allowed to spring up straight to permit the hardening of plane surfaces such as motor suspension guide bars. The machine is thus capable of a large variety of work and is simple in operation, nothing being left to the operator's judgment. He has only to load and unload it, and push the starting button.

Another interesting application of flame hardening was the production of wearing surfaces on the shoulders of spool-type rollers for large gun mounts. Again, only a portion of the total surface required hardening and had to be controlled between the rather severe limits of 45-48 Rockwell C. The geometry of this piece obviously made it well adapted to the spinning method of flame hardening; therefore, apparatus was designed on that basis. Since the roller was of large mass it was impractical to quench it by dropping it into a bath as is often done on smaller pieces. The alternative was to heat and quench the spool without changing its position. This method was used, the spool being spun in the vertical position until proper surface temperature was obtained, at which time the flames were shut off and the quench applied.

Surfaces to be hardened were on the sloping shoulders of the spool. To get the heating and quenching heads sufficiently close to the sloping surface it was necessary that they extend inside the bell ends of the spool. Because of this the machine could be loaded and unloaded only by providing some means of swinging the heating and quenching heads out of the way. This was done by pivoting each head at its support and attaching a sprocket to the vertical shaft on which each turned. The sprockets all engaged a chain that ran horizontally around the machine and could be moved by a hand lever. Thus, a movement of the lever swung all the heads out of the way to allow the spool to be lifted off its turntable. These details may be seen in *Fig.* 3.

The quenching medium in this instance was air. It was introduced in specially constructed heads similar to the flame heads and placed alternately with the flame heads around the job. Two problems arise in connection with the use of air as a quenching medium; those of cleanliness and temperature. Ordinary compressed air may carry particles which will obstruct the orifices in a quenching head and alter the effectiveness of the quench. To overcome this difficulty it was necessary to put a strainer in the line. The temperature of the air varied considerably with atmospheric temperature and produced variations in results until an ice bath was provided through which the air was passed to assure uniform temperature. This machine was also made completely automatic, the cycle being controlled entirely by electrical means.

Fig. 3—Multiple flame-head machine hardening wearing surfaces on gun-mount roller. Sprocket and chain device swings flame heads out of way for loading

PUBLISHER'S ANNOUNCEMENT

Colin Carmichael

Penton Publishing Co. is pleased to announce the appointment of Colin Carmichael as Editor of MACHINE DESIGN.

He succeeds Laurence E. Jermy who, as editor of the publication from its beginning in 1929 to date, has played an important part in its development into one of the outstanding professional magazines in the field of business paper publishing. Although Mr. Jermy is relinquishing his executive duties as editor, he will continue to serve MACHINE DESIGN actively in a consulting and contributing capacity.

As editor, Mr. Carmichael will be assisted by John W. Greve, who will continue as managing editor but with broader duties, and by the present editoral staff which will be expanded during the next few months in order that MACHINE DESIGN may continue to improve its editorial service.

Mr. Carmichael is well qualified to guide the editorial destiny of MACHINE DESIGN in the exciting years ahead. Born in Scotland shortly after the turn of the century and educated in Scotland, England and the United States, he was employed successively as apprentice marine engineer, draftsman, and sea-going engineer officer. After coming to this country he became associated with Sun Shipbuilding and Drydock Co., Chester, Pa., on the design of marine steam and diesel engines.

A naturalized American citizen, he was successively instructor and assistant professor at the University of North Carolina, Cornell University, and Rutgers University, specializing in machine design subjects. In 1942 he became associate editor of MACHINE DESIGN. He is also editor of the design and production volume of the forthcoming 12th edition of "Kent's Mechanical Engineers' Handbook."

Mr. Carmichael holds bachelor's and master's degrees in mechanical engineering and has been active in numerous engineering societies, including the American Society of Mechanical Engineers, Society of Automotive Engineers, American Society for Engineering Education, and Institution of Engineers and Shipbuilders in Scotland. He is a member of Tau Beta Pi and is a registered professional engineer in the State of Ohio.

The publishers of MACHINE DESIGN are confident that under the guidance of Messrs. Carmichael and Greve the staff, with the assistance of Mr. Jermy, not only will maintain the high standards of editorial performance established during the past two decades but will elevate them to new heights to the benefit of its constantly increasing numbers of readers.

THE PENTON PUBLISHING COMPANY

E. L. Shaner

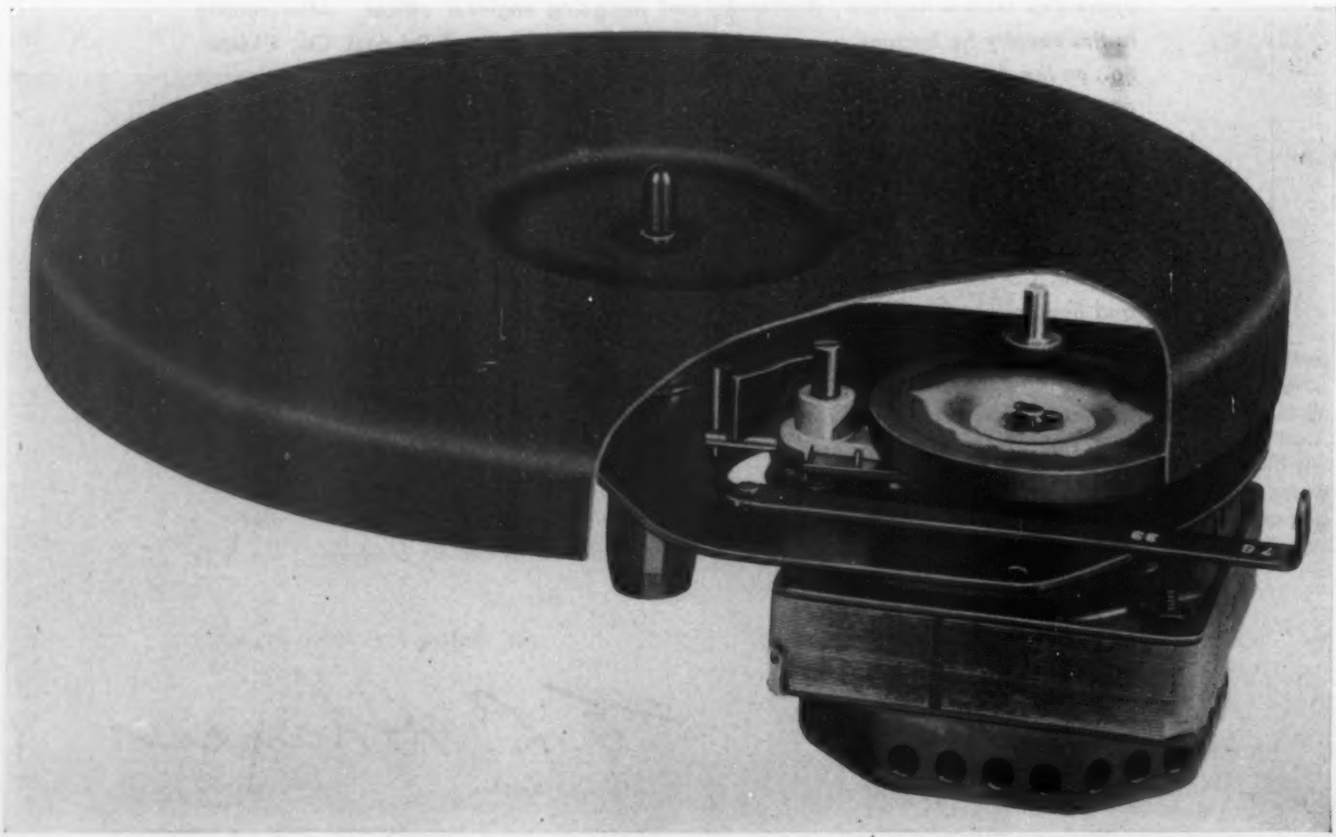
President

DESIGNS OF THE

Dual-Speed Turntable Motor

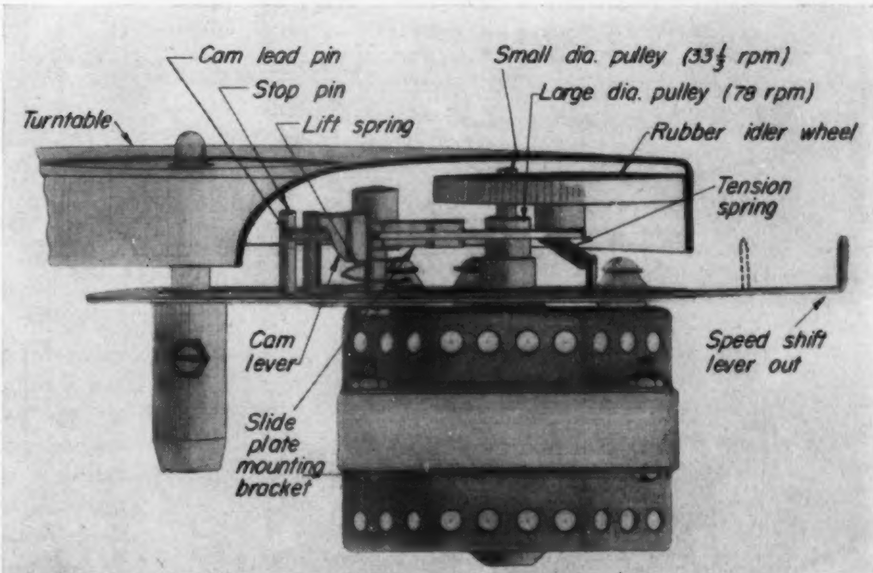
PERMITTING the use of a single turntable motor for both 33 1/3 and 78-rpm record-player operation, the mechanism shown in the accompanying photograph, below, is both unusual and simple in operation. Rotation of the turntable while in either speed is accomplished in the conventional manner; an idler wheel is in contact with and is driven by an extension of the motor shaft which serves as a two-step pulley.

Changing from one speed to the other is accomplished as shown in the drawing, top, next page. During 33 1/3 rpm operation, the speed-shift lever is in the "out" position and the idler wheel is in contact with the smaller (upper) section of the rotor shaft. Pushing in the speed-shift lever causes the cam lever to rotate in a clockwise direction around its mounting stud. This cam lever engages a cam lead pin, which is attached to the slide plate bracket, and rotates the bracket assembly clockwise about the mounting stud, pulling the idler wheel out of contact with the rotor shaft. Idler wheel travel is stopped when the cam lead pin contacts the stop pin. Further movement of the speed-change lever causes the cam lever to move the restrained cam lead pin and entire idler wheel assembly vertically downward against the force of the lift spring. At the end of the downward vertical travel of the slide plate bracket, the lead pin contacts the flat portion of the cam lever, permitting the idler-wheel tension spring to pull the idler back into contact with the lower and larger diameter section of the rotor shaft, as shown in the photograph below. To shift back from fast to slow turntable speed, the speed-shift lever is pulled out, rotating the cam lever in a counterclockwise direction and permitting the lift spring to move the mounting bracket assembly idler



wheel vertically upward and then into contact with the small diameter of the rotor shaft, assuming the position shown in the drawing, right.

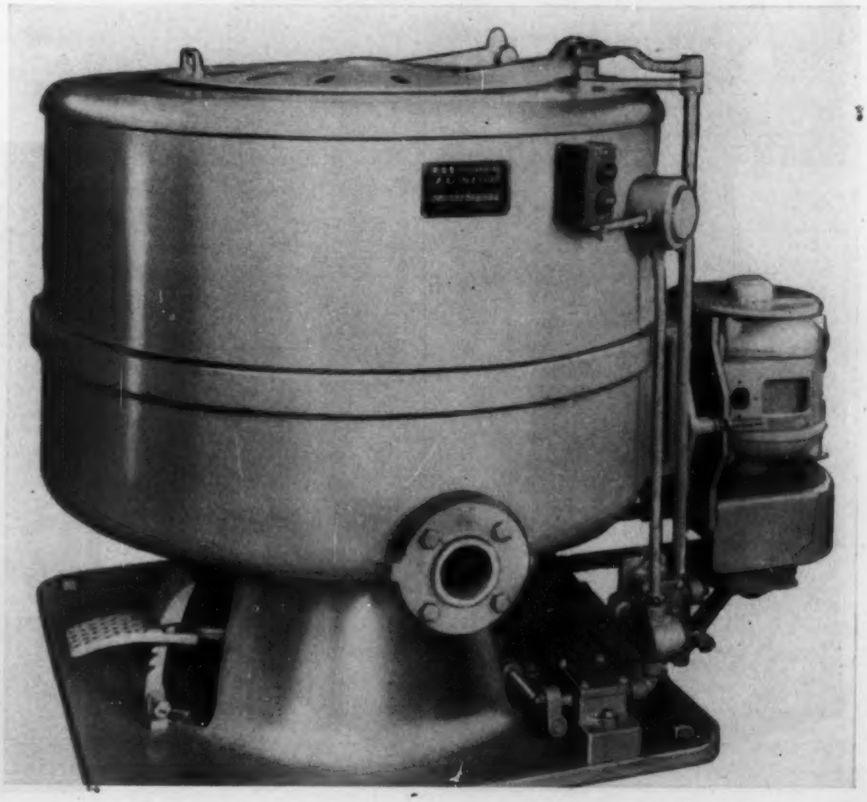
Small vibrations and shaft runout of the rotor shaft are isolated from the turntable by the resiliency of the rubber casing molded on the idler wheel. The idler wheel slide plate is free to move horizontally in the slide plate bracket, enabling the idler wheel to seek its own center and compensate for any possible out of round of the turntable. Motor is of the shaded-pole induction type, designed for low stray field radiation. Manufacturer: General Industries Co., Elyria, Ohio.

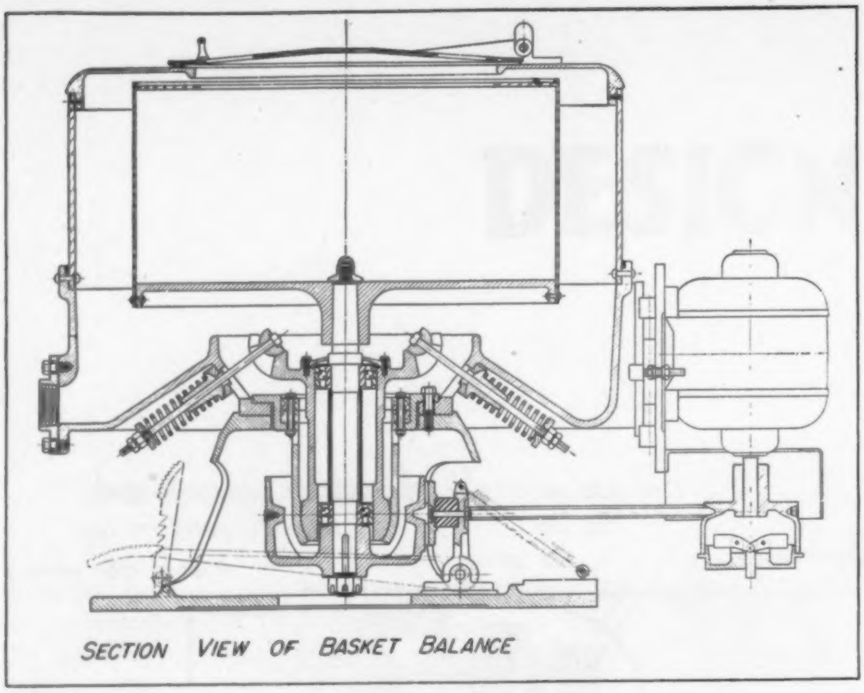


SPEED SHIFTING MECHANISM

Spring-Balanced Extractor Basket

POSSIBLE unbalance of a loaded basket in the commercial laundry extractor shown in the photograph, right, is compensated by a spring suspension system. As the cross section drawing top, next page shows, the basket-supporting shaft and bearing assembly rests in a spherical seat, and is supported in an upright position by steel springs which permit the necessary oscillations. The springs have been placed near the stainless-steel basket, where the unbalanced forces occur, to obtain the maximum stabilizing effect. The brake is equipped with a renewable brake band, and is interlocked with the current to the motor so that current and brake cannot be on at the same time. An

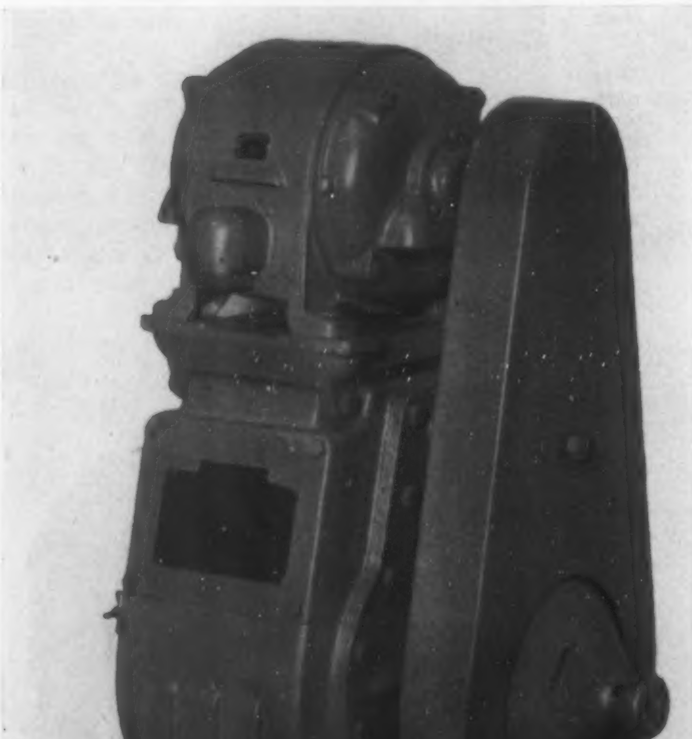


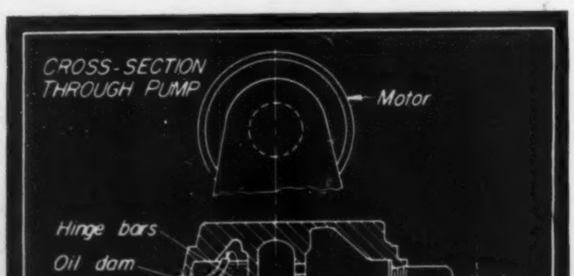


aluminum cover on the machine is interlocked with the basket so that the machine will not start until the cover is closed and must be stopped before the cover can be opened. A hinged motor mount permits compensation for stretch of the V-belt used in the drive. Manufacturer: Fletcher Works Inc., Philadelphia.

High Vacuum Pump

VACUUMS as high as 5 microns (0.005 mm. of mercury) are produced by the Microvac pump shown, left. Key to the high volumetric efficiency of the units is the simple exhaust valve mechanism consisting of a feather valve, a rigid backing plate and springs which return the feather valve to its seat. The heavy steel valve plate has a number of valve ports which are covered by the synthetic feather valve. Pressure is applied against the steel backing plate by beryllium copper springs. Any pressure differential between the atmospheric pressure and that inside the pump causes the feather valve to open. A positive head of oil is maintained above valve assembly to prevent air flow back through the valve and subsequent re-expansion in the pump cylinder. Pumping action is derived from an eccentric and rotary piston arrangement as shown in the drawing below. An

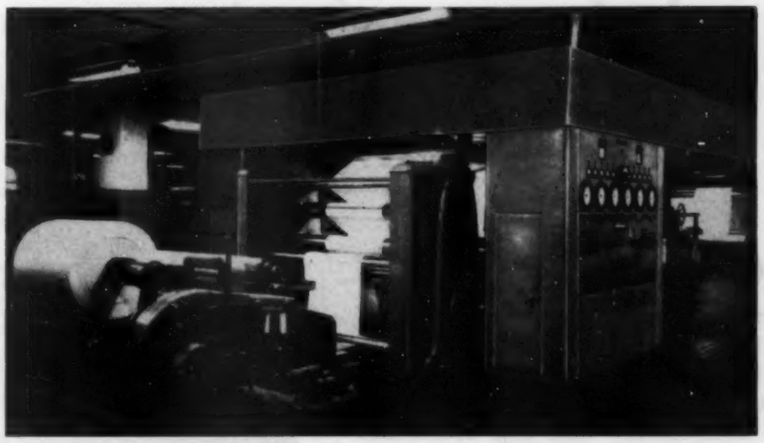


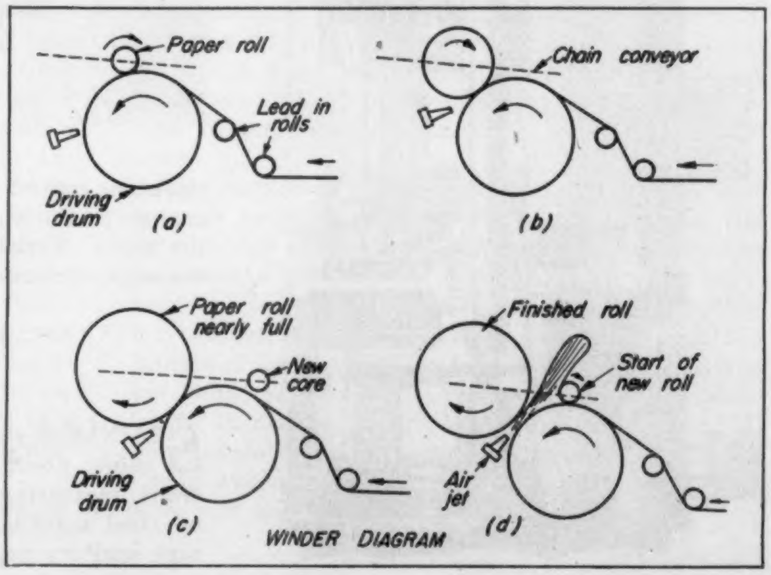


interesting feature of the pump is the method of lubrication of the main bearings and pump cylinder. Oil from the reservoir in the base is drawn by the vacuum in the cylinder first to the sleeve type main bearings, and then, along grooves in the shaft, into the pump cylinder. Excess oil and condensed moisture are forced out of the cylinder with the discharged air and are separated from the air by an oil separator baffle in the base. The exhaust valve will discharge sudden slugs of water or other liquids without damage to the pump. Manufacturer: F. J. Stokes Machine Co., Philadelphia.

Paper Coating Machine

SPECIALLY designed winder on the paper coating machine shown at the left in the photograph top, right, permits changing from a full roll to an empty core at any speed up to the 1000 feet per minute capacity of the machine. The machine, capable of handling paper rolls 80 inches wide and 38 inches in diameter, consists of a Waldron unroll and "micro jet" coater visible in the photograph right-center, right and left respectively, a Ross drying chamber, partially shown in upper part of picture, a back coating unit, and Waldron web tension control unit and winder. An air jet "doctor" in the coater proper blows off any excess coating applied at the applicator roll and leaves a controlled amount of coating on the web. Operation of the winder, as can be seen from the drawings lower right, is as follows: A large chromium plated driving drum drives the roll of paper at constant surface speed. As the roll builds up in diameter, it is automatically moved to the left on the chain conveyor as shown at *a* and *b*. As the take up roll approaches the desired diameter, *c*, a new core is placed in the starting position but out of contact with the driving drum. To change the web from the finished roll to the new core, the latter is first dropped into contact with the driving drum and begins to revolve at the same surface speed as the web. The finished roll and the new core are then both advanced a few inches by means of the chain conveyor, moving the completed roll away from the driving drum. Since the completed roll is no longer being driven it begins to slow up, and the paper forms a loop between the roll and the new core which is still at web speed. This loop is blown up and over the new core by means of a blast of compressed air, *d*, and the operator glues the core and starts the paper winding on the new roll. The loop is now winding up on both rolls, and when the slack is gone the web pulls tight with a snap that breaks the paper and frees the completed roll. Manufacturer: John Waldron Corp. for Ozalid Div. of General Aniline and Film Corp., Johnson City, N. Y.





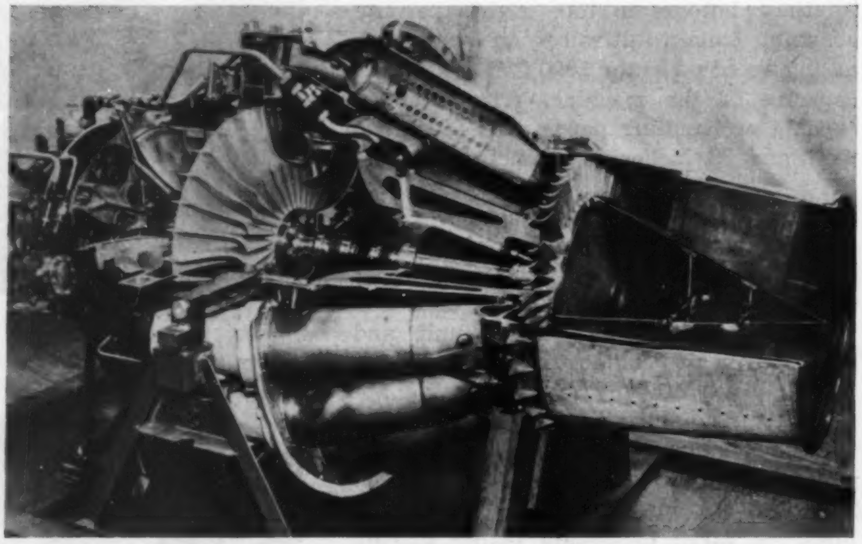
WINDER DIAGRAM

Applications

of engineering parts, materials and processes

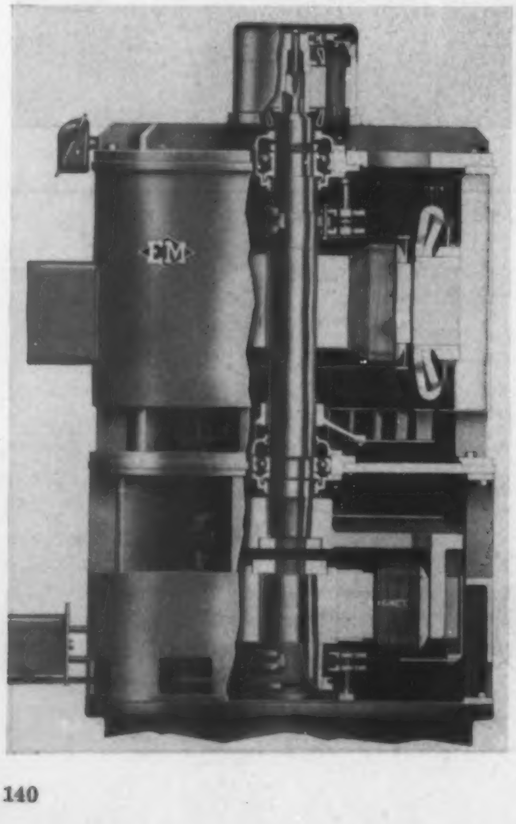
Has High Temperature Resistance

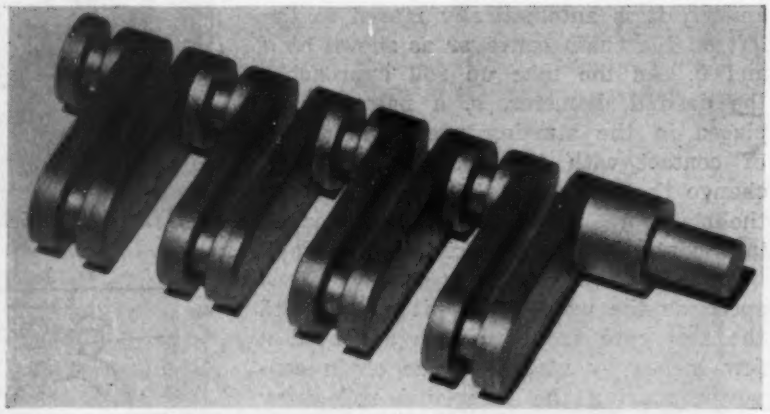
COMBUSTION chambers of the I-40 turbojet engine, right, are subjected to temperatures of 1600 F at starting and 1200 to 1400 F during flight. To withstand this heat, the combustion chamber liners, domes and clip assemblies are International Nickel's Inconel.



Magnet Acts as Drive

ELECTROMAGNETIC device is used for speed control in the Electric Machinery Mfg. Company's centrifugal pump drive unit, below. Signal from a liquid level control together with signal from an electric tachometer on pump shaft are received by electronic control which interprets them and makes corresponding change in the current to an eddy-current clutch at output of the drive. Variation is this current results in clutch slip and consequently change in pump speed.





Crank Is Precision Cast

STAINLESS-steel conveyor crank for doughnut making machine, above, is precision cast by Allis-Chalmers. The crank, measuring 3⅞ inches long and 1½ inches high, requires no final machining and its smooth as-cast surface meets the high sanitary requirements of the food-machinery industry.

Calculating Flywheel Effect of V-Belt Sheaves

By H. A. Wilson
Texrope Department
Allis-Chalmers Manufacturing Co.
Milwaukee, Wis.

IN THE design of multiple V-belt drives, the flywheel effect, or wr^2 value, of the driven sheave is often of major importance. Sometimes a designer may only be interested in knowing what the flywheel effect of the sheave is going to be, but often the nature of the machinery requires a certain definite wr^2 quantity to be achieved in the driven sheave.

The common method in such cases is to select a standard drive to fit the particular application, and to determine the flywheel effect of the corresponding sheave which would be employed. If this value is not sufficient to meet the requirements, the additional weight necessary to give the desired wr^2 value is determined and a new sheave is designed which incorporates this additional weight into its rim.

Determining the additional thickness required in the sheave rim is a cut-and-try method requiring extensive and tedious calculations. To reduce the amount of calculation and to aid in selection of a better drive, the chart on the following page has been prepared. This chart shows the wr^2 per inch of rim width (ordinate), the weight to be added per inch of rim width (abcissa), and driven sheave diameters (diagonal lines). Plotted as diagonal lines at the left of the chart are wr^2 values per inch of rim width for standard sheaves for *B, C, D,* and *E* section belts.

Use of the chart can best be shown by an example. Suppose that a compressor drive is required, transmitting 75 hp and having a wr^2 value of 2500 lb-ft^2. The squirrel-cage motor operates at 1200 rpm and the compressor speed is to be 350 rpm. For this application, a suitable standard drive would consist of six D195 belts, a motor sheave with a diameter of 14.6 inches, a driven sheave with a diameter of 48 inches, and a center distance of 46.3 inches.

The diagonal line for a 48-inch sheave is drawn on the chart, and extended until it intersects the diagonal line for a D-section standard sheave. This point of intersection, read at the right-hand scale of the chart, gives a value of 155 lb-ft^2 for the standard sheave. From the manufacturer's catalog it is found that the sheave rim width is $8\,^{15}/_{16}$ inches. The total wr^2 value is then $155 \times 8\,^{15}/_{16}$, or 1385 lb-ft^2. Since this is less than the desired value, additional rim weight is needed on this sheave.

To find the amount of additional weight needed by use of the chart, the desired wr^2 is first divided by the rim width: $2500/8\,^{15}/_{16} = 280$. This gives the required wr^2 per inch of rim width. From 280 on the ordinate, a horizontal line is drawn to the intersection of the sheave diameter line, which in this case is the 48-inch line previously drawn. From the intersection, a vertical line is dropped to the bottom of the chart where the weight to be added per inch of rim width is read. The value in this case is 48. Multiplying this figure by the rim weight of $8\,^{15}/_{16}$ inches gives 429 lb as the amount of extra weight which must be added to the rim of a standard D-section 48-inch six-groove sheave, to give a wr^2 value of 2500 lb-ft^2.

This method of determining flywheel effect can also be used to save material. For example, if the rim width of the sheave just referred to were increased to 10 inches, a value of 250 lb-ft^2 rather than 280 lb-ft^2 would be required per inch of rim width, and following through the previous steps, it is found that 348 pounds of metal would be needed to give the desired wr^2 value, 81 pounds less than was previously calculated. Increasing the rim width still more would further reduce the weight needed, but factors such as size of available patterns and space available for the drive will usually limit the rim width increase.

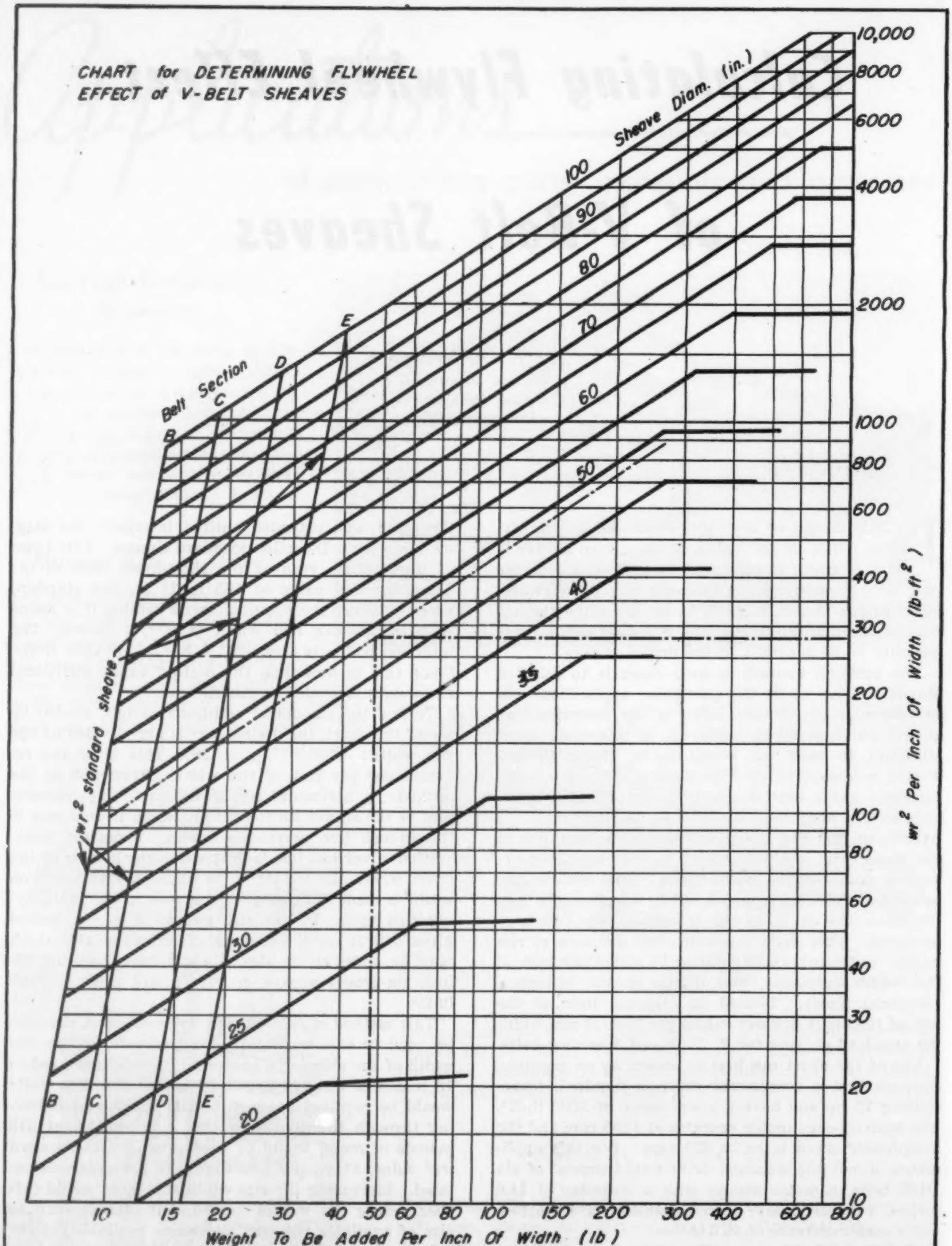


CHART for DETERMINING FLYWHEEL
EFFECT of V-BELT SHEAVES
Sheave Diam. (in.)
100
90
80
70
60
50
40
35
30
25
20
Belt Section
B
C
D
E
wr^2 standard sheave
10,000
8000
6000
4000
2000
1000
800
600
400
300
200
100
80
60
40
30
20
10
wr^2 Per Inch Of Width ($lb\text{-}ft^2$)
10
15
20
30
40
50
60
80
100
150
200
300
400
600
800
Weight To Be Added Per Inch Of Width (lb)

Men OF MACHINES

WILLIAM C. JORDAN, formerly vice president and general manager of Wright Aeronautical Corp., the engine-building division of Curtiss-Wright Corp., as well as general manager of the company's airplane division, was recently elected president and director of both Curtiss-Wright Corp. and its subsidiary, Wright Aeronautical Corp. Mr. Jordan is well known in the aviation industry, having had 24 years experience in aeronautical engineering and production work. He was graduated from the U. S. Naval Academy in 1922, and started with the Steel Products Engineering Co., Springfield, Ohio, as sales engineer in 1924. He served successively as factory manager, general manager and vice president of the company, retaining the latter two positions until 1947. Early in 1948 he joined Curtiss-Wright as general manager of the airplane division at Columbus, Ohio. Mr. Jordan is also president of the Seymour Tool and Engineering Co. Inc., Seymour, Ind. and chairman of the board of B. M. Heede Inc., New York. In addition to being a director of the Lagonda National Bank of Springfield, Mr. Jordan has retained his interest in the Steel Products Engineering Co. as a member of the board of directors.

William C. Jordan

SELDEN T. WILLIAMS, vice president of Scovill Manufacturing Co. Inc., Brooklyn, N. Y., has been appointed general manager of A. Schrader's Son division of that company, manufacturers of pneumatic and hydraulic fittings and equipment. He joined the Scovill company in 1929 and in 1944 was elected vice president in charge of manufacturing in Schrader domestic and foreign plants. Mr. Williams received his mechanical engineering degree from Worcester Polytechnic Institute in 1916 and earned his master's degree from St. Lawrence University in 1926. He served at the Naval Aircraft Factory in Philadelphia as assistant experimental engineer and chief engineer from 1917 to 1922, when he went to the Victor Talking Machine Co. in Camden, N. J. for seven years. Of the many devices developed by Mr. Williams, the rotating pressure joint used in the oxygen supply systems for aircraft gun turrets and in the famous Army "Duck" for controlling tire pressure to suit terrain is perhaps the best known. In addition to his many civic responsibilities, Mr. Williams is a member of the Society of Automotive Engineers and Sigma Xi.

Selden T. Williams

Sidney A. Whitt

SIDNEY A. WHITT, for the past four years director of engineering for Cordley & Hayes, manufacturers of water coolers, has been elected vice president of engineering for the company. On being graduated from the college of engineering, University of Alabama, Mr. Whitt was awarded the Tau Beta Pi postgraduate fellowship and carried on advanced work at Massachusetts Insti-

tute of Technology. He served in engineering and technical executive capacities with the York Corp., Nash-Kelvinator Corp., Fedders Manufacturing Co., and the Baker Ice Machine Co. before joining Cordley & Hayes. Mr. Whitt has contributed many developments and inventions to the refrigeration and air conditioning industry, among them a wind tunel for research on heat transfer equipment, railroad heating equipment, high temperature brazing furnaces, a code for rating unit heaters, and a graphical method for rapid selection of finned type heating and drying coils. His method for rating air conditioning equipment has been presented in a handbook. Mr. Whitt's professional affiliations include membership in the American Society of Mechanical Engineers, American Society of Refrigerating Engineers, American Society of Heating and Ventilating Engineers, Society of American Military Engineers, American Society for Engineering Education, and American Society of Sanitary Engineers. In his new position, Mr. Whitt will be responsible for all development, design and application engineering for water cooling and other allied fields.

♦

JAMES W. MORAN was recently elected president of the Baker-Raulang Co., Cleveland, succeeding E. J. BARTLETT who becomes president emeritus and continues as director of the company, manufacturers of power industrial trucks and rubber-tired mining machinery.

♦

GEORGE T. CHRISTOPHER, president and general manager and J. G. VINCENT, vice president of engineering of the Packard Motor Car Co. have received the "Certificate of Merit", signed by President Truman in behalf of the Department of the Air Force, for their services in the engineering and mass production of aircraft engines during the war.

♦

MALCOLM PIRNIE, consulting engineer and head of the firm of Malcolm Pirnie Engineers, New York, was named winner of the 1948 Hoover Medal in special recognition of his leadership in the formulation of a program sponsored by the Engineers Joint Council for the postwar industrial control of Germany and Japan. Four national engineering societies, the ASME, ASCE, AIEE, and AIMME, jointly awarded the medal to Mr. Pirnie.

♦

ROBERT H. MORSE, JR., vice president in charge of all operations of Fairbanks, Morse & Co., was elected president and treasurer of the Diesel Engine Manufactures Association at the recent annual meeting.

♦

WILLIAM A. WILDHACK is the new chief of the missile instrumentation section of the electronics division, National Bureau of Standards. He will be responsible for the direction of flight tests of guided missiles and the development of equipment for evaluating their performance. Among the many technical developments credited to Mr. Wildhack are variable-tension spring transducers and design formulas for corrugated diaphragms used in pressure-measuring equipment.

♦

WILLIAM A. BEATTY recently was named manager of the feeder division of the Westinghouse Electric Corp. Mr. Beatty was with the Ford Motor Co. for several years before coming to Westinghouse in 1916.

♦

THEODORE VON KARMAN, director of the Guggenheim Aeronautics Laboratory at the California Institute of Technology, has been appointed an honorary professor of mechanical engineering at Columbia University. Dr. von Karman is best known for his theories of vortex motion and turbulence in fluids and for his work in supersonic aerodynamics. He is a consultant to the Northrop Aircraft Co., General Electric Co. and the Aerojet Engineering Corp.

♦

ELMER H. WAVERING has been named vice president of product design for Motorola, Inc., manufacturers of radio and television equipment.

♦

RICHARD M. SOMERS, previously assistant chief engineer of the Ediphone division of Thomas A. Edison, Inc., West Orange, N. J., now holds the position of chief engineer. Mr. Somers joined the company in 1928 as a research engineer, later serving as chief engineer and factory superintendent of the lamp division. He succeeds SAMUEL G. LANGLEY who had been in charge of engineering activties in the Ediphone division since being employed by Mr. Edison himself in 1911. Mr. Langley will act as consultant to the division.

♦

JOSEPH F. LASK, associated with the automotive, tool and machinery industries since 1912, has been appointed general manager of the Modern Collet & Machine Co., Ecorse, Mich. Mr. Lask has served as chief engineer of Mail-O-Meter Mfg. Co. and F. Joseph Lamb Co., and has held managerial positions with Midwest Tool and Mfg. Co. and Gairing Tool Co.

♦

J. C. FINK, with the Westinghouse Electric Corp. since 1927, is now manager of the industry engineering department of the company.

♦

HARRY B. MILLER has accepted the appointment as chief engineer in charge of design and development for Money-Meters, Inc., Providence, R. I., manufacturers of fare registers.

♦

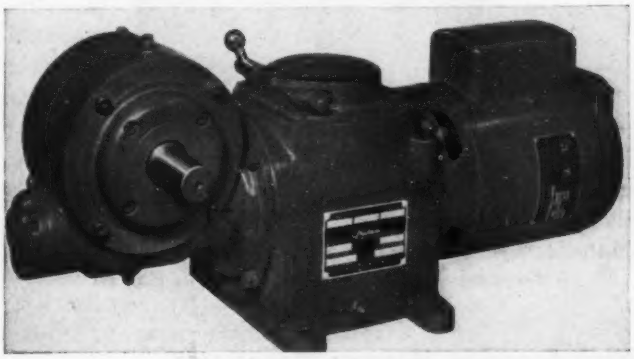
STANWOOD W. SPARROW, vice-president in charge of engineering at Studebaker Corp., South Bend, Ind., is the newly elected president of the Society of Automotive Engineers. His more recent activities include his being in charge of Studebaker's wartime program of building Wright Cyclone engines for the armed forces. A sketch of Mr. Sparrow's career appeared in the May 1948 issue of MACHINE DESIGN.

new parts and materials

For additional information on these new developments see Page 271

Variable-Speed Transmissions

Two additions have been made to the Graham line of variable-speed transmissions. The first of these is the model 41M having a built-in electric motor and Stearns magnetic brake. Instant stoppage is thus provided when power is shut off. Model 41MW has built in motor and worm reducer, giving reduction ratios of 5:1, 12:1, 18:1, 27:1, and 54:1 in the various types. Gear box may be fastened to the transmission housing to give four positions—right, left, up or down. Transmissions have heavy cast-iron frames and are mounted by means of four bolts. Manufacturer: Graham Transmissions, Inc., 3754 N. Holton St., Milwaukee 12.



For additional information circle MD 1 on Page 271

Extreme-Service Gear Grease

Keystone grease No. 32 retains its plasticity, tenacity and density from subfreezing temperatures to 400 F. Intended particularly for use with open gears, the lubricant repels water up to the boiling point. The grease is packed in "tooth paste" type applicators. Manufacturer: Keystone Lubricating Co., 2112 Lippincott St., Philadelphia 34.

For additional information circle MD 2 on Page 271

Miniature Ball Bearing

Having large ID to OD ratio, new ball bearing for use on ⅛-inch shafts requires only a ¼-inch housing. The bearing is of the full-race, radial type with fifteen 1-mm balls. All surfaces are precision finished and all tolerances are ABEC 5. Bearing is available in both SAE 52100 chrome alloy bearing steel and AISI 440 stainless steel. Manufacturer: Miniature Precision Bearings Inc., Keene, N. H.

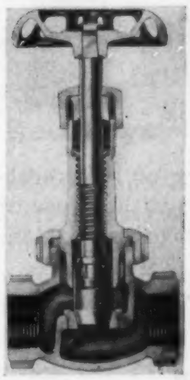
For additional information circle MD 3 on Page 271

Bright-Chromate Zinc Coating

For use in finishing zinc plating, new Iridite process produces a bright chromate coating on zinc. The coating makes zinc stain resistant and offers good corrosion resistance. Degree of brightness and corrosion resistance can be controlled. Salt-spray corrosion resistance ranges from 24 to 100 hours depending on the iridescence desired in the finish. Manufacturer: Allied Research Products Inc., 4004 E. Monument St., Baltimore 5.

For additional information circle MD 4 on Page 271

Plug Type Globe Valve



Suited for use in severe service, the type 976-A plug type bronze globe valve is recommended for such applications as pressure regulation, temperature regulation and flow throttling. Feature of the new valve is the alloy seat and special plug. Seat is JX 500, a special alloy stainless steel, heat treated to 500 Brinell. The material has ductility at this hardness. The slip-on, stay-on plug is simple in design and has T-slot for engaging spindle head. Valve has heavy sections and deep stuffing box. V-shaped lugs on union bonnet ring and body ends permit the use of any type wrench. Sizes available are ¼ to 2 inches inclusive; rating is 300 lb. Manufacturer: Jenkins Bros., 80 White St., New York.

For additional information circle MD 5 on Page 271

Automatic V-Belt Clutch

Fully automatic clutch for V-belt drives is suitable for use with gasoline or electric power sources. The clutch is disengaged when belt is running free at starting or idling speeds. As speed is increased the clutch gradually takes up the load until operating

speeds are reached with the clutch fully engaged. The unit, known as the Flex-A-Matic, causes only normal wear on the V-belt, although the belt is the only wearing part. Pulley is part of the clutch assembly. Clutch can be adjusted during manufacture to pick up the load at any desired rpm. It can be made in any size within the limits of V-belt application. Manufacturer: W. S. K. Inc., 405 Donovan Bldg., Detroit 1.

For additional information circle MD 6 on Page 271

Nickel-Alloy Drawn Wire

Wire drawn of Hastelloy and Multimet is now available in sizes down to 0.060-inch in diameter and below. Wire is furnished in coils or in cut and straightened lengths either bare or flux coated for welding. Applications of the wire include springs for high temperature service. Manufacturers: Haynes Stellite Co., Kokomo, Ind. (diameters down to 0.060-inch) Kemet Laboratories Co. Inc., Madison Ave. and W. 117th St., Cleveland (sizes below 0.060-inch).

For additional information circle MD 7 on Page 271

Hand-Operated Pneumatic Valves

Line of Numatics hand-operated pneumatic valves now have a number of additional features. They are made in both locking and nonlocking types with shielded levers having 40-degree movements. Lever styles include upright, double chain and V-cam or dog trip. This last type is suitable for use in obtaining reversing or reciprocating motion. Units are pressure sealed without use of springs or stuffing boxes and are noncorrosive. Manufacturer: Numatics, Milford, Mich.

For additional information circle MD 8 on Page 271

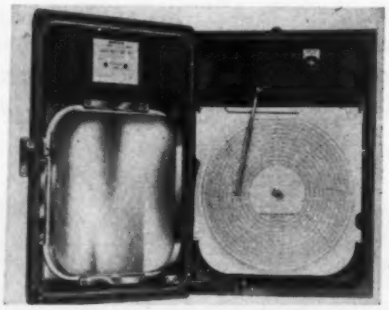
Automatic Two-Speed Transmission

New automatic transmission provides a broad range of speeds as well as special ratios not usually available with motors alone. Transmission consists of two overrunning clutches, one engaging in a clockwise and the other in a counterclockwise direction. One clutch provides direct drive at a 1:1 ratio; the other drives at a preselected ratio, clutch actuation being automatically caused by reversal of the motor. The units are built to ratings of 5, 10, 15, 20, 25 and 50 hp, any ratio between 1:1 and 6.31:1 being available. Manufacturer: Western Mfg. Co., 3400 Scotten Ave., Detroit 10.

For additional information circle MD 9 on Page 271

Operation-Recording Instrument

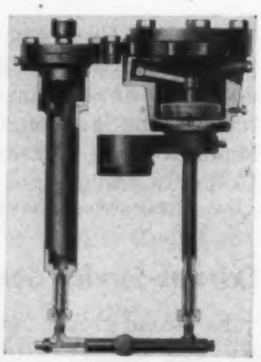
Running-count recorder plots on a circular chart a curve of the number of operations being counted against time. It can record the total count of intermittent operations and the time at which each one



occurs, and can thus be used on production and similar machinery to record operations or production. Manufacturer: The Bristol Co., Waterbury 91, Conn.

For additional information circle MD 10 on Page 271

High-Accuracy Mercury Manometer



Designed for use in indicating, recording and controlling pressures, new high-pressure mercury manometer has a high energy output made possible by large diameter float. The instrument has a pressure range up to 1500 psi and positive overload protection to provide against loss of mercury from over range, sudden pressure fluctuation and flow reversal. Special pressure-tight bearing is stainless steel with Teflon bearing surfaces and assures no freezing, low friction and leak-proof performance. Manufacturer: Taylor Instrument Co., Rochester 1, N. Y.

For additional information circle MD 11 on Page 271

Quick-Exhaust Valve

Model QE quick exhaust valve is suitable for use with air, oil and water at pressures from 0 to 200 psi. It has positive high-speed action, is noncorrosive throughout and has long life. Only moving parts are two poppets made of stainless steel. Unit is unique in operation since fluid pressure automatically

JOHNSON BRONZE

SLEEVE BEARING DATA

CAST BRONZE

JOHNSON BRONZE

SLEEVE BEARING DATA

Selecting the Alloy

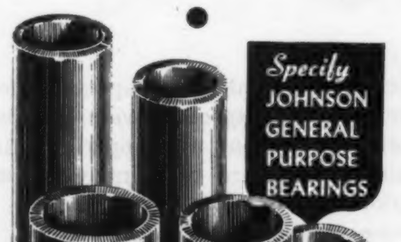
The many and various applications for sleeve-type bearings make necessary the availability of a variety of bearing metals possessing many distinctly different properties. Each particular bearing metal must be best suited for those conditions of service wherein its outstanding characteristics will be of greatest advantage. Accordingly, in the selection of a bearing material it is necessary that the service conditions and the destructive forces on the bearing be analyzed first and the bearing material be then selected for each specific application.

The first step is to accumulate accurate operating data such as speeds and loads . . . whether constant or intermittent . . . method of lubrication; the presence of acid, harmful chemicals, gases, grit or dust; the type of shaft to be used.

All sleeve bearings operate in direct contact with the shaft until the creation of the necessary film of lubricant. Consequently, the following physical properties govern the suitability of a bearing metal: (1) Plasticity; (2) Ability to Resist Wear; (3) Coefficient of Friction; (4) Compressive Strength; (5) Resistance to Pounding; (6) Toughness.

While there are over one hundred bronze bearing alloys from which to make your selection, we have found through experience that the following will meet practically every application.

Johnson Bronze Alloy No.	Average Chemical Composition				
	Copper Cu	Tin Sn	Lead Pb	Zinc Zn	Nickel Ni
19	70.0	11.0	19.0	. . .	. . .
25	75.0	5.0	19.0	. . .	1.0
27	80.0	10.0	10.0	. . .	. . .
29	78.0	7.0	15.0	. . .	. . .
51	87.0	10.0	1.0	2.0	. . .
53	88.0	10.0	. . .	2.0	. . .
55	86.0	12.0	. . . .	2.0	. . .
66	85.0	5.0	9.0	1.0	. . . .
71	85.0	5.0	5.0	5.0	. . .
72	83.0	7.0	7.0	3.0	. . .



Stock Size Bearings

For ordinary service applications and for quick, easy replacement Johnson Bronze maintains a stock bearing service that comprises over 850 individual sizes. This includes inside diameters from ¼″ to 4¼″; outside diameters run from ⅜″ to 4½″; lengths are available from ¾″ to 8″. All of these sizes can be quickly altered and any type oil groove, slot or hole can be economically added. Complete stocks are carried in all important industrial centers.

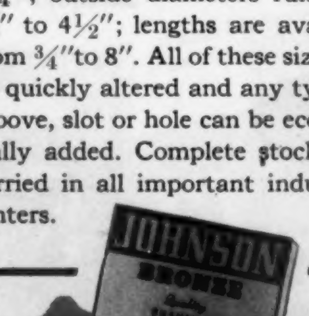
Engineering Service

Johnson Bronze offers manufacturers of all types of equipment a complete engineering and metallurgical service. We can help you determine the exact type of bearing that will give you the greatest amount of service for the longest period of time. We can show you how to design your bearings so that they can be produced in the most economical manner. As we manufacture all types of Sleeve Bearings, we base all of our recommendations on facts free from prejudice. Why not take full advantage of this free service?

This bearing data sheet is but one of a series. You can get the complete set by writing to—

Catalogue

Over eighty pages fully illustrated. Lists and describes the most complete stock bearing service in the market. Write for your free copy.



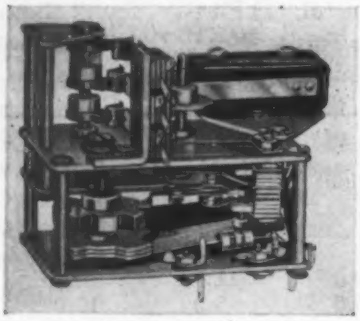
Johnson Bronze

SLEEVE BEARING HEADQUARTERS
525 S. MILL ST. • NEW CASTLE, PENNA.

opens the exhaust port to the atmosphere when the main control valve is returned to normal position. Valving action is actuated by fluid through two poppet elements, obviating fluid return through long piping to the main operating control valve. Valve is furnished with cast naval bronze body, stainless poppets and oil-resistant rubber valve seats. Standard sizes include ¼, ⅜, ½, ¾ and 1 inch. Manufacturer: Airmatic Valve Inc., 1643 E. 40th St., Cleveland.

For additional information circle MD 12 on Page 271

Constant-Speed DC Motor

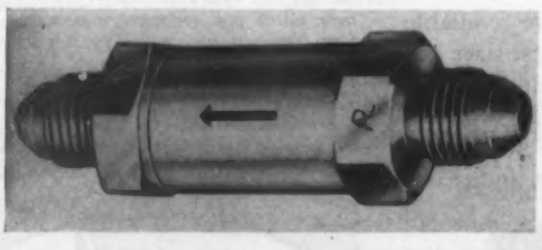


Constant-speed d-c motor uses as its basis of operation polarized magnetic drive of a vibrating reed. It is therefore, effectively a synchronous dc motor. Motor frame and aluminum reduction gearing measures 2½ by 3½ by 1⅝ inches and weight is 10 ounces. Made in styles suitable for line or battery voltages from 3 to 110, the motor has a rotor shaft speed of 900 rpm. Built-in reduction gears, cams and switching arrangements can be furnished to suit requirements. Manufacturer: Amglo Corp., 4234 Lincoln Ave., Chicago 18.

For additional information circle MD 13 on Page 271

Cone Check Valves

High performance check valves qualify under Army-Navy aircraft standards requiring life tests of 50,000 cycles at peak impulse pressures of 150 per cent of rated pressure. They are designed for uniform, low-pressure drop over a wide range of flow rates. Valves are available with aluminum bodies and



stainless-steel poppets for pressures to 1500 psi, or with cadmium-plated steel bodies and heat-treated steel poppets for 3000 psi service. Ports are male or female threaded in ⅛ or ¾-inch pipe size, or fitted for tube sizes ¼-inch through 1 inch OD. The Tube connection ends have a 37 degree flare angle. All types function in the temperature range of −65 to +160 F, opening under 4 to 8 psi of directional pressure. Manufacturer: Parker Appliance Co., 17325 Euclid Ave., Cleveland 12.

For additional information circle MD 14 on Page 271

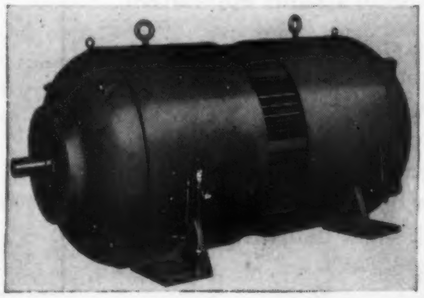
Chromium Plated Parts

Bulk plating of small parts such as screws, stampings and screw-machine parts can be done without racking. Cost is thus greatly reduced. Finish produced is bright and lustrous, comparing to finish usually attained by buffing. Processer: Midwest Chrome Process Co., 83 E. Milwaukee Ave., Detroit 2.

For additional information circle MD 15 on Page 271

Fan-Cooled Induction Motors

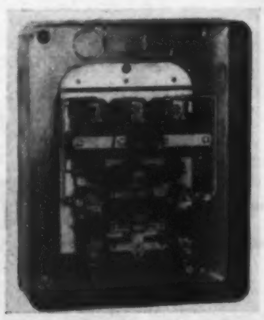
Line of totally inclosed, fan-cooled induction motors is available in wide range of speeds, and ratings from 250 to 500 hp. They are of the 2-pole squirrel-cage type rated 55 C rise continuous duty and are made in 2 or 3-phase, 60-cycle types for 440, 550



or 2300 volt operation. The units are especially designed for direct drive of high-speed blowers, pumps, compressors and other equipment when operating in atmospheres containing moisture or abrasive dust. Manufacturer: Burke Electric Co., Erie, Pa.

For additional information circle MD 16 on Page 271

Solenoid-Operated Starters



Solenoid-operated Bulletin 4113, Size 3 ac magnetic starters are intended for use in applications where across-the-line, nonreversing starting of polyphase squirrel-cage induction motors and single-phase motors is permissible. Starters are made with open type construction for built-in or specialized controls, or with NEMA Type I general-purpose enclosures. They can be controlled by separate pilot devices or can be supplied with local control pushbuttons or selector

switches. Features include high arc-interruption capacity, reliable thermal overload protection and compact construction. Maximum enclosed rating is 50 hp at 440/550 volts, 3-phase, 60 cycles. Standard operating coils can be supplied for 110, 220, 440 and 550 volt, 25 or 60 cycle service. Dual voltage coils can be furnished for 110/220 or 220/440 volt, 60-cycle operation. Manufacturer: Ward Leonard Electric Co., Mount Vernon, N. Y.

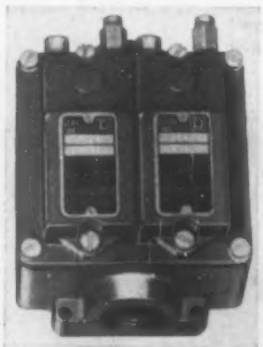
For additional information circle MD 17 on Page 271

Copper-Base Alloys

Five new copper-base alloys for electrical and mechanical applications have recently been announced. They are designated 601, 602, 603, 606 and 607. Type 601 has greater strength, hardness and wear resistance than copper and is resistant to corrosion such as is encountered in contacts. Type 602 is a heat-treatable alloy combining high electrical and thermal conductivity with high strength and hardness. It is recommended for applications which involve excessive electrical overloads or elevated temperature. Type 603 is a heat-treatable alloy with high strength as well as good electrical and thermal conductivity. It has high elasticity and fatigue resistance and is recommended for use as springs, engine parts, etc. Type 606 is superior in electrical and thermal conductivity, as well as possessing good machinability and low friction. It is also hard and has high fatigue resistance and elasticity. It has been used for such parts as current-carrying bearings. Type 607 is suitable for use in current-carrying parts subjected to continuous or intermittent mechanical stresses, abrasion, heat, etc. It is said to have a heat-treated strength in excess of any other known copper-base alloy. The endurance strength is almost equal to that of spring steel and the specific strength equal to that of lightweight alloys. Manufacturer: Fansteel Metallurgical Corp., North Chicago, Ill.

For additional information circle MD 18 on Page 271

Duplex Limit Switches



Duplex limit switches allow the use of a single switching unit where two limit switches are ordinarily needed. By the use of the two oil-tight switches in a single duplex unit only one run of conduit is required for necessary control wires. Both surface mounting and flush mounting types are available. Each switch has a single-pole, double-throw snap-action mechanism and two electrical circuits, one normally open and the other normally closed. The flush mounting unit consists of two limit switch assemblies mounted on a square steel plate provided with a mounting gasket. For surface mounting a diecast box is added. The box can be attached so that the conduit axis is either longitudinal or transverse with respect to the switch units. Ratings are 600 volts, ac or dc. Manufacturer: Square D Co., 4041 N. Richards St., Milwaukee 12.

For additional information circle MD 19 on Page 271

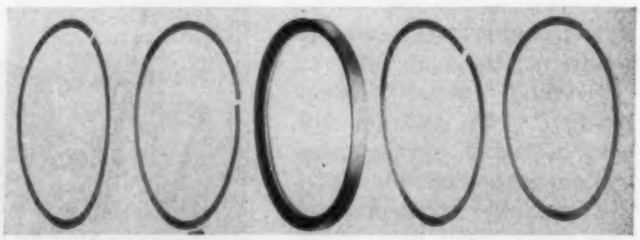
Mercury-Vapor Thyratron

Useful in relay-control applications, the mercury-vapor thyratron 672-A is an improved version of the old thyratron 672. It is completely interchangeable with the older tube. Some of the changes made in the unit consist of reduction of heater current from 6 to 5 amperes, increase of the maximum peak forward and inverse anode voltage ratings from 1500 to 2500 volts, an increase of the maximum average anode current from 2.5 to 3.2 amperes. Overall length of the tube has been decreased by 1/4 inch. Present dimensions of the unit are 7 1/8-inch, seated, and 2 5/16 inch maximum diameter. Bulb style is T-18, cap is of the skirted medium type and the base is a large shell, super-jumbo 4-pin, bayonet style. Manufacturer: Radio Corp. of America, Harrison, N. J.

For additional information circle MD 20 on Page 271

Nonextruding Ring Packing

Consisting of resilient sealing ring of synthetic rubber supported by nonextrusion rings of phenolic laminate, Palmetto G-T ring packing will not extrude into the clearance space between mating parts. The packing may be used in any hydraulic or pneumatic system where a positive seal is necessary. It may serve as a static seal where there is constant or impulse pressure or as a dynamic seal where there is reciprocating motion with either constant or impulse pressure. Packings may be used in systems where the temperature range is from −70 to +250 F and



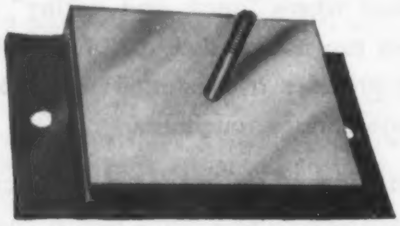
will not leak or fail over extended periods of operation at pressures up to 3000 psi. Typical applications are shock absorbers, control valves, cylinders and swivel fittings. Not recommended are applica-

tions involving continuous rotary motion. The packing is available in two styles: External or piston type and internal or rod seal. Manufacturer: Green, Tweed & Co., North Wales, Pa.

For additional information circle MD 21 on Page 271

Vibration Mounts

Line of heavy-duty vibration mounts includes type CM for cushioning horizontal and rotary vibration and type CM-V for cushioning vertical vibration. The latter type is designed for use with top-heavy ma-



chines where vertical vibration causes recoil and rocking. In both designs there is no use of rubber-to-metal bonds, the inserts being held in place by steel retaining brackets. Manufacturer: Finn & Co., 2850 8th Ave., New York 30.

For additional information circle MD 22 on Page 271

Magnetic Starter and Contactor

Motor starter and contactor is designed to give protection to ac motors up to 50 hp at 440 volts. Two features of the unit are relay heaters and a plastic enclosed coil. The bimetallic relay heaters accurately follow the heating curve of the motor, relay is adjusted for either automatic or manual reset by movement of a lever. The plastic enclosed coil is intended to give greater life to the windings by protecting them from moisture, corrosion and abrasion. It has a lubricating material impregnated into the plastic to keep magnet guides sliding smoothly and eliminate low-voltage chatter. Manufacturer: Trumbull Electric Mfg. Co., Plainville, Conn.

For additional information circle MD 23 on Page 271

Drip-Proof Polyphase Motors

Polyphase motors in frame sizes 254, 284, 324, and 326 are now being made with the drip-proof design which has previously been used only in the sizes 225 and smaller. The motor frames are formed of heavy rolled steel shaped to center accurately the stator core, and provide passages between the frame and core for ventilation. An auxiliary fan, larger in diameter than the armature of the motor, draws in air through the openings in one endplate and forces it out through the openings in the other end. Screens add protection by preventing the admission of rags and similar foreign objects. Manufacturer: Wagner Electric Corp., 6400 Plymouth Ave., St. Louis 14.

For additional information circle MD 24 on Page 271

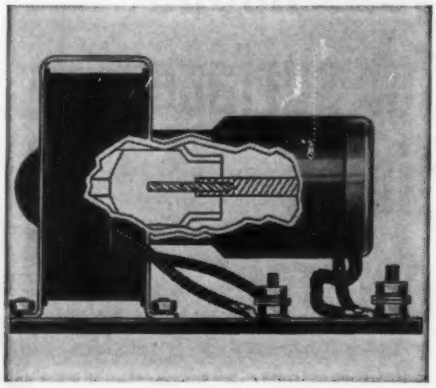
Silicone-Rubber Sponge

Suitable for use as gaskets and vibration mounts, silicone-rubber sponge retains its properties through the temperature range −70 F to +500 F. Having half the bulk of solid material, the sponge is correspondingly cheaper; it is available in extruded or molded shapes as well as sheets. Manufacturer: The Connecticut Hard Rubber Co., 407 East St., New Haven 9, Conn.

For additional information circle MD 25 on Page 271

Mercury Type Relays

Operating on the double-flow principle, new line of hydrogen-quenched mercury relays have low arcing, as well as reduced heat and corrosion characteristics. Four types are available: Quick-operate, quick-release; quick-operate, slow-release; slow-operate, slow-release; and slow-operate, quick-release.

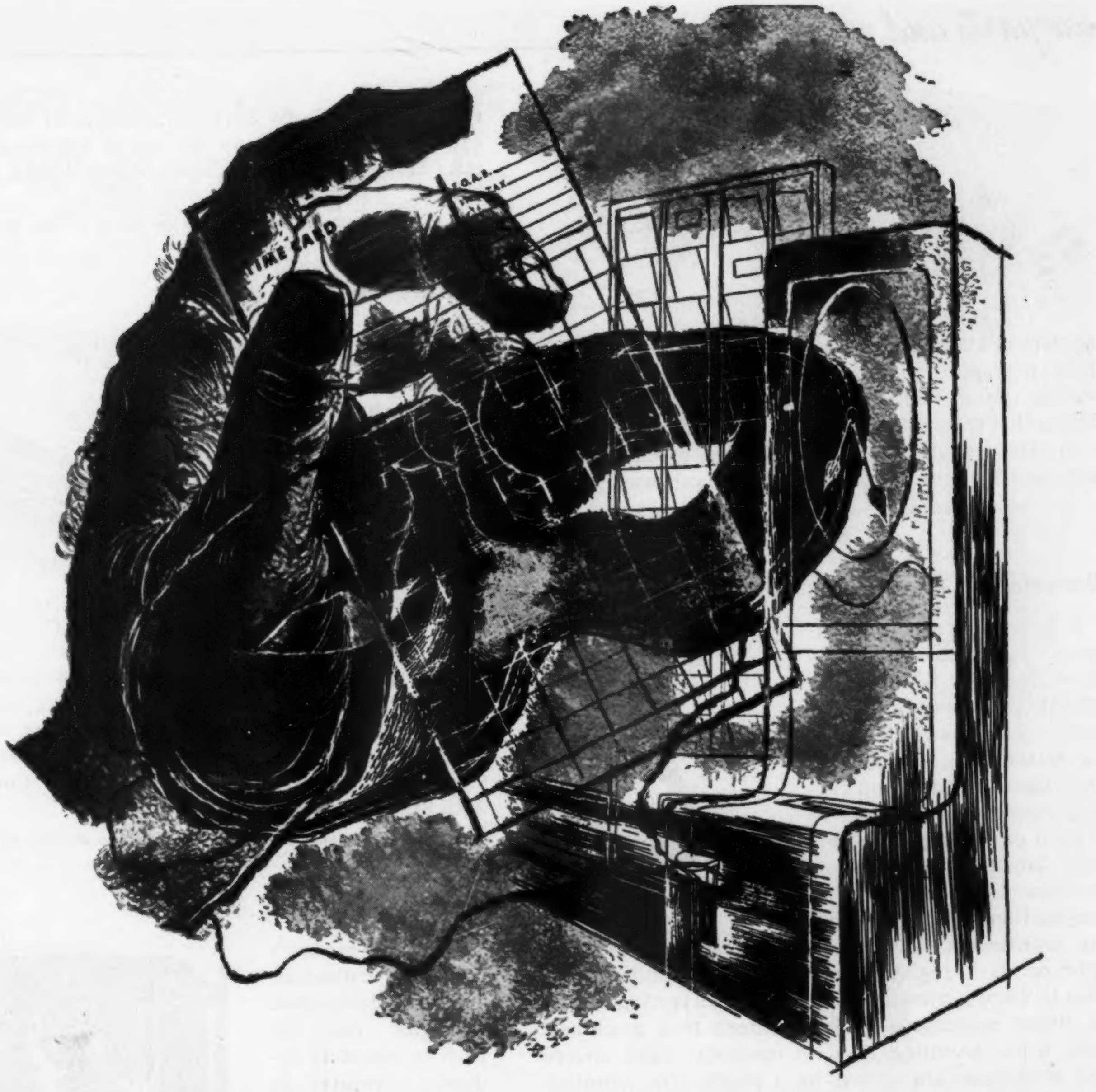


Time delays are available to provide delays from 0.15 to 20 seconds, and the relays are made in single or multiple units. Single units are provided in 2 sizes—30 or 60 amperes. The relays are suitable for the switching of heavy loads including inductive ones such as solenoids and motors. Manufacturer: Durakool Inc., Elkhart, Ind.

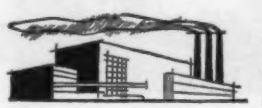
For additional information circle MD 26 on Page 271

Reciprocating Ball Bearing

Series B commercial-grade ball bushings are an inexpensive version of the Series A linear ball bushing. They are built to the same basic dimensions as



Are the machines you design safe from this PRODUCTION THIEF?



He works in thousands of plants—choking, stifling and slowing machines, upsetting production schedules—costing industry untold sums of money that *can* be saved.

He masks his identity well. But here are some clues.

Do the machines you design have to be lubricated by hand—the old, time-wasting, hit-or-miss method?

It is possible to save up to 23.9 man hours in applying each 100 lbs. of grease.

Need your machines be shut down for lubrication? Is there the danger of product spoilage because of messy leakage of lubricants? You can banish these.

There is a way to lubricate hundreds of bearings from one central point, with the right grease in the correct amount—without risk of contamination—while the machine continues to produce.

Do you recognize this "production thief" now? His disguise is machines which must be lubricated the wasteful, old-time way—at dozens of different points. Are you including him in every machine you design?

There is one proven way to stop this.

An Alemite representative can tell you in 10 minutes how to design this "production thief" *out* of your machines.

He can show you how Alemite Centralized Lubrication Systems reduce many lubrication points to one . . . protect the machines you design against the risks of human error . . . assure positive, precise lubrication for even the most inaccessible bearings.

Use the phone. Call your Alemite distributor. Or write to Alemite, 1804 Diversey Parkway, Chicago 14, Illinois.

ALEMITE

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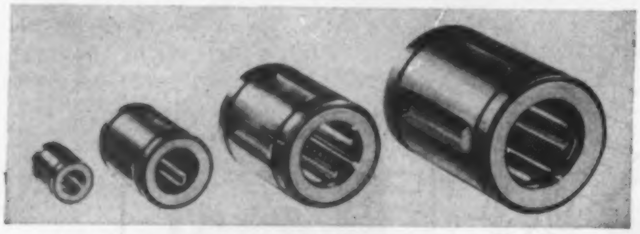
MODERN LUBRICATION METHODS THAT CUT PRODUCTION COSTS

Another Product of STEWART WARNER



the Series A bushing but have neither the close tolerances nor quite the load capacities. However they provide the same low-friction, lasting alignment and elimination of binding and chatter. Bearings are now in production for ¼, ½, ¾ and 1-inch shafts. Manufacturer: Thomson Industries Inc., Manhasset, N. Y.

For additional information circle MD 27 on Page 271

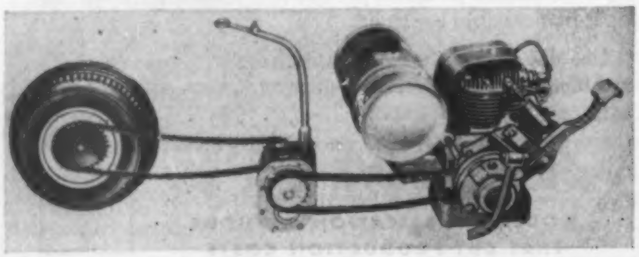
Photoelectric Registration Control

High sensitivity and high-speed operation are combined features of the type 23LF3 photoelectric registration control. Designed for maintaining accuracy in high-speed printing and cutting operations, the control is used on packaging, printing, labeling and cut-off machinery. It operates in conjunction with opaque and translucent materials and operates from either light or dark registration marks. The unit can be used to control virtually any type of correcting means on either continuous or intermittent feed machines. Split beam scanning head is compact; light source and phototube are served by a single lens handling both transmitted and reflected light. Circuit will respond to impulses as short as 1/1000 of a second. Manufacturer: Photoswitch Inc., 77 Broadway, Cambridge 42, Mass.

For additional information circle MD 28 on Page 271

Gasoline Power Unit

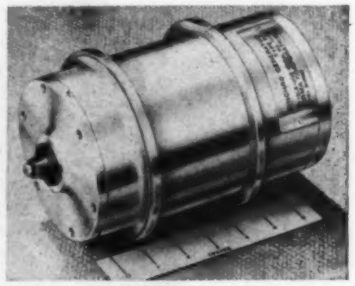
Combining a 4-cycle single-cylinder engine, a disk type clutch and a sliding gear transmission, the Cushman Power Unit develops 4 hp at 3200 rpm. It has two speeds forward and one in reverse, reduction being 2.24:1 in low and 1:1 in high. Various speed



reductions down to 33:1 in addition to those indicated can be attained by the use of standard sprockets. Manufacturer: Cuchman Motor Works, Lincoln, Nebr.

For additional information circle MD 29 on Page 271

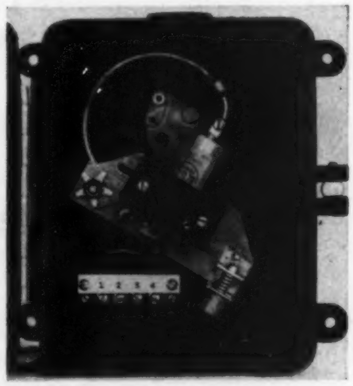
Synchro Units



Designed specifically for electronic, electromechanical and electrohydraulic control systems as well as remote indication, new line of synchro units is highly accurate and well damped. Included in the line are control transformers, motors, generators, differential motors and differential generators. The units are designed for operation from single-phase, 115-volt, 60-cycle current; the secondaries are three-wire systems for 90 volts, maximum. Secondary windings of the transformer are scaled to a gradient of one volt per degree. Manufacturer: Arma Corp., 254 36th St., Brooklyn 32, N. Y.

For additional information circle MD 30 on Page 271

Pressure Measuring Device



Pressure measuring and indicating system designated Atcotran can be used to remotely indicate pressures in the range 0 to 10,000 psi with a reported accuracy of ¼ of 1 per cent. Instrument pickup uses a Bourdon tube as a measuring device. This tube, however, is not loaded, the Atcotran armature doing the necessary work to deliver the signal. Made of K-Monel, the tube is mounted in a dust-tight enclosure suitable for service in many corrosive atmospheres. The receiver is of the electrical type. Ranges available include: 0-30, 0-300 and 0-500 psi as well as 0-1000, 0-5000 and 0-10,000 psi. Manufacturer: Automatic Temperature Control Co. Inc., 5212 Pulaski Ave., Philadelphia 44.

For additional information circle MD 31 on Page 271

High-Strength Heater Cord

New type heater cord known as Preen-X eliminates use of asbestos through a new principle of insulat-

tion. It is of solid parallel conductor design; has smooth rubber-like appearance. It has high abrasion resistance and resists kinking; in addition it is water and oil proof. Manufacturer: General Electric Co., Bridgeport 2, Conn.

For additional information circle MD 32 on Page 271

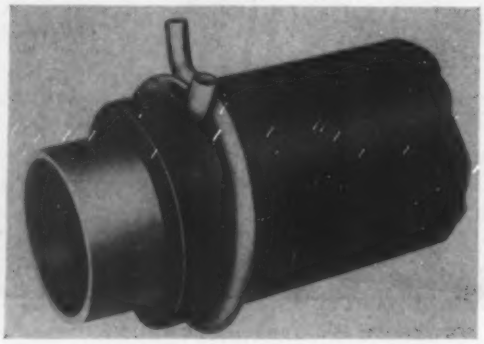
Hard-Surfacing Powder

Applied by means of a carbon electrode, "Surfaceweld A" hard surfacing powder produces a thin chromium carbide surface that is resistant to abrasive wear and corrosion. Particularly suitable for use on thin work and for ac application, the material has a hardness of 54-61 Rockwell C in single layer deposits and 57-63 in multiple layers. Manufacturer: Lincoln Electric Co., Cleveland 1.

For additional information circle MD 33 on Page 271

Self-Tightening Hose Clamp

Consisting of heat-treated steel wire formed to a perfect circle, the new Corbin hose clamp is self tightening and is particularly recommended for restricted space applications. The clamp is installed by squeezing it open with pliers and slipping it over the connection. It forms a flexible seal that requires no bonding compound. The units are suitable for use

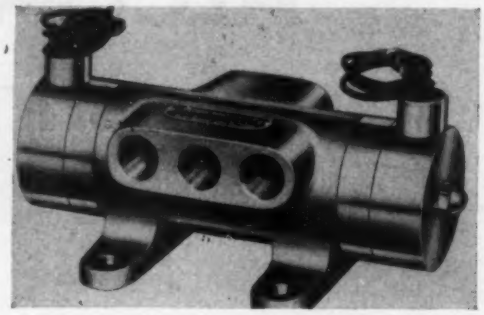


where rubber or fabric hose is connected to metal tubing. They are available in sizes to fit hose with outside diameters from 7/16 to 2⅝ inches and are cadmium plated to resist corrosion. Manufacturer: Corbin Screw Div., American Hardware Corp., New Britain, Conn.

For additional information circle MD 34 on Page 271

Pneumatic Control Valves

Compact solenoid-operated 4-way pneumatic control valve measures 10⅜ inches overall in the larger, ¾-inch port, size. The ⅜-inch port model measures 7¼ inches overall. Body of the valve is a heat-treated aluminum alloy casting; valve piston is brass, sealed with aircraft type O-ring packings. Unit is so designed that the solenoid coils actuate small secondary valves which in turn control air internally ported from the incoming pressure port. The main valve piston is thus forced to extreme position at each actuation by the injection of air pressure. The electrical system is protected from contact with operating air. Valve is designed for operation on maximum line pressures of 150 psi, coils are furnished for 110/220-volt operation with current consumption of 1



ampere at 110 volts. Units with 440-volt coils are also available. Manufacturer: Modernair Corp., 4222 Hollis St., Oakland 8, Calif.

For additional information circle MD 35 on Page 271

All-Metal Vibration Mount

Steelflex vibration mountings incorporate a new all-metal resilient material which provides protection against shock and vibration. The mounts are stable, drift resistant and load-tolerant, and are inherently damped. They have nonlinear load-deflection characteristics. Manufacturer: Robinson Aviation Inc., Teterboro, N. J.

For additional information circle MD 36 on Page 271

Hydraulic-Electric Power Units

Line of hydraulic-electric power units with built-in Gyrol fluid drive are made in sizes ranging from 1 to 20 hp. Each unit has standard NEMA mounting bolt hole dimensions and all units are complete with electric motors. The drives provide smooth acceleration, overload protection and shock absorption as well as low starting current. Motor starts unloaded and comes up to 85 per cent full speed before starting the load. Manufacturer: American Blower Corp., Detroit 32.

For additional information circle MD 37 on Page 271

engineering dept equipment

In order to obtain additional information on this new equipment see Page 271

Drafting Table

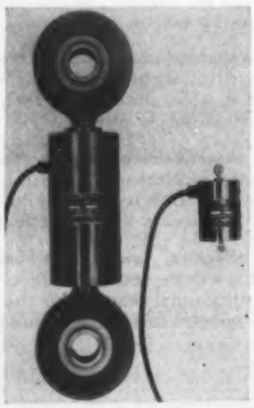
All-wood drafting table is made in five top sizes. This latest addition to the 7700 series of four-post drafting tables features 5-ply basswood drawing top, linoleum-covered foot rest and solid oak construction. Tables are available with or without drawers, with

tool drawer only or with tool drawer and shallow drawer. An auxiliary unit having a file drawer and a supply drawer can also be supplied. Manufacturer: Engineering Mfg. Co., Sheboygan, Wis.

For additional information circle MD 38 on Page 271

Universal Load Cell

Tension and compression loads can be measured by means of the type SR-4-U strain-measuring load cell. Pick-up elements consist of resistance-wire strain gages which are bonded to a steel load-responsive member and hermetically sealed within a sturdy cylinder. Dimensions of this sensitive member change slightly under load, increasing or decreasing the length of the gage wires and thus changing their electrical resistance. Change is calibrated in units of weight which may be indicated by a pointer or dial, or recorded on a chart. Fittings for tension or compression loads are attached by means of female threaded connections on both ends of the cell. For compression loads a bearing button is screwed into the top and the base is rested on a bearing surface or attached to suitable supports. Four load capacities are available: 500, 2000, 10,000 and 50,000 pounds. Manufacturer: Baldwin Locomotive Works, Philadelphia 42, Pa.



For additional information circle MD 39 on Page 271

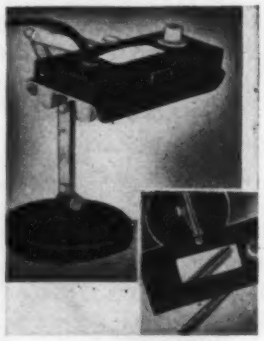
Transfer Forms

Plastic transfer forms, known as Transeals, adhere readily and require no heat or pressure in application. They are suitable for use with standard forms such as title blocks, finish and heat treatment notes, and tables of symbols, and take the place of hand ruling and lettering or rubber stamps. Two types are available: Type RI for use on the reverse side of transparent paper and cloth, and Type DI for use on the face of opaque paper and metal. Manufacturer: C. M. Johnson Co. Inc., Bethpage, N. Y.

For additional information circle MD 40 on Page 271

Illuminated Magnifier

Provided with two 5-inch fluorescent tubes, magnifying unit illuminates its subject with 350 foot-candles of light. Because the point of observation is directly behind the light source, the 2-power magnification reveals details of holes and cavities as well as surfaces. Standard fixture is finished in black wrinkle with baked white enamel reflector.



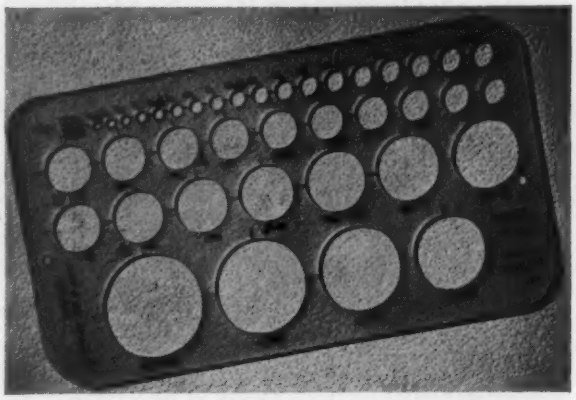
Length is $6\frac{1}{4}$ inches, weight 10 ounces. Four-watt lamps are standard units rated at 2500 hours life, and are available in daylight or white types. Power requirements are 115 volts, 60 cycles. Various brackets are available to meet mounting requirements. Manufacturer: Stocker and Yale, 48 Birch St., Marblehead, Mass.

For additional information circle MD 41 on Page 271

Circle Template

No. 40 drafting template can be used for drawing 39 circles ranging in diameter from 1/16 to $1\frac{3}{8}$ inches. Circles with diameters from 1/16 to 21/36 are provided in steps of 1/64-inch. From 11/32 to

21/32 the steps are 1/32-inch and from 1 to 1⅜ inches the steps are ⅛-inch. Circles are identified by whole numbers equal to the diameters in 64ths of an inch. The template is made of 0.030-inch cellu-



lose nitrate with milled cutouts and printing on negative side to reduce wear. Size is 4 by 7¼ inches. Manufacturer: Rapidesign Inc., P. O. Box 592, Glendale, Calif.

For additional information circle MD 42 on Page 271

Vibration-Measuring Instrument

Pocket-sized vibration-measuring instrument has a range of 800 to 16,000 rpm. The instrument utilizes as a measuring device a thin spring-steel reed which is tuned by means of a thumb wheel. When the instrument is placed in contact with a vibrating body, the reed is virtually motionless until it is adjusted to a point at which its natural frequency matches the frequency of the motion being studied. At that point, the reed vibrates strongly indicating that a critical point has been reached. The vibration rate can be found by reference to a graduated scale on the body of the instrument. The device, known as the Rev-Tuner, measures 7 inches in length and weighs 3 ounces. It is finished in gray enamel. Manufacturer: Rev Products Co., 406 Market St., Elmira, N. Y.

For additional information circle MD 43 on Page 271

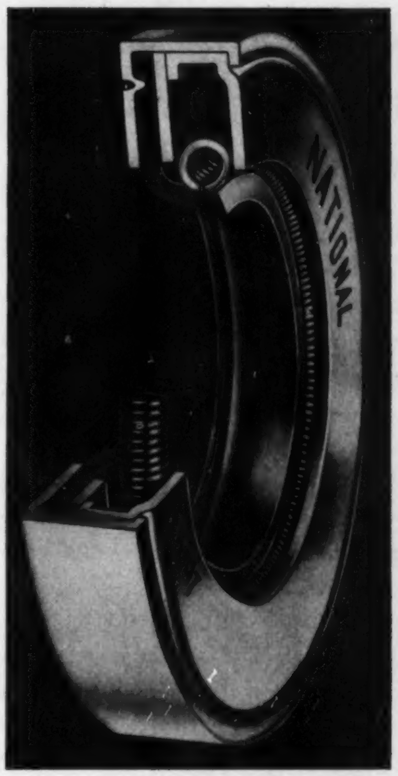
Drafting Instrument

Plastic drafting instrument known as the Arcaid is useful in locating the positions of tangent arcs. It can be used in such work as locating the tangents to straight or curved lines, or in determining clearances, checking dimensions or visualizing radii or arcs without drawing them in. The instrument gives arcs

NATIONAL OIL SEAL LOGBOOK

CHARACTERISTICS AND LIMITATIONS OF SPRING-LOADED LEATHER OIL SEALS

The broad applicability and outstanding performance of the single-member spring-loaded leather oil seal has made this design the most widely used of all oil seals. Together with a similar design in synthetic rubber, these single-wipe seals account for more than 80% of all seals used today.



There are three important reasons why spring-loaded leather seals have proven so successful in a wide variety of applications:

1. **They seal effectively on relatively rough shafts.**
2. **Permit wide tolerance in shaft size.**
3. **Operate well under oil starved conditions for long periods.**

The spring-loaded leather seal is limited in operation as to speed (2000 FPM); temperature (200° F.); pressure (20 lbs. psi), and run-out (.010 indicator reading). However, the spring-loaded leather seal is virtually the only design that provides good protection on rough shaft surfaces . . . up to 65 RMS with low leakage. This same inherent characteristic also permits a wide latitude in the machining of shaft diameters—an important advantage in high speed production of equipment.

A distinct advantage of the spring-loaded leather oil seal is its rugged construction. Such seals, particularly the 50,000 series National Oil Seal (illustrated), are built with a heavy cross-section. This allows the seal case to withstand hard knocks during assembly, and provides a margin of safety against inexpert replacement techniques in the field.

And, furthermore, because the leather sealing members are porous enough to retain lubricant within themselves, these seals can operate under dry conditions for some time . . . a safety margin against neglect of lubrication.

Single-wipe spring-loaded leather seals are the most completely tooled of all designs, and production quantities are generally available in almost any standard bore or shaft size. Spring-loaded leather National Oil Seals (National 50,000 series) are available from stock in more than 850 different size combinations. For complete information, write direct to factory or get in touch with the nearest National Oil Seal Engineer. (See list below.)

NATIONAL
OIL AND FLUID SEALS ®

NATIONAL MOTOR BEARING CO., INC.

General Offices: Redwood City, California
Plants: Redwood City and Los Angeles, California; Van Wert, Ohio

CALL IN A NATIONAL ENGINEER FOR RECOMMENDATIONS

BUFFALO: 56 Arlington Place, Grant 2280. **CHICAGO:** Room 2014 Field Building, Central 6-8663.
CLEVELAND: 210 Heights Rockefeller Building, Yellowstone 2720. **DALLAS:** 30½ Highland Park Village, Justin 8-8453.
DETROIT: Room 1026 Fisher Building, Trinity 1-6363. **HOUSTON:** 6731 Harrisburg Boulevard, Wayside 3-1246.
LOS ANGELES: 2244 East 37th Street, Kimball 6384. **MILWAUKEE:** 1717 E. Kane Place, Lakeside 2838.
NEW YORK CITY: 122 East 42nd Street, Lexington 2-8260. **PHILADELPHIA:** 401 North Broad Street, Bell-Walnut 2-6997.
REDWOOD CITY, CALIF.: Broadway and National, Emerson 6-3861. **WEST SPRINGFIELD, MASS.:** 1025 Elm Street, Springfield 2-1881.
EAST SYRACUSE, N. Y.: 226 Roby Avenue, East Syracuse 366. **WICHITA:** 340 North St. Francis Street, Wichita 2-6971.

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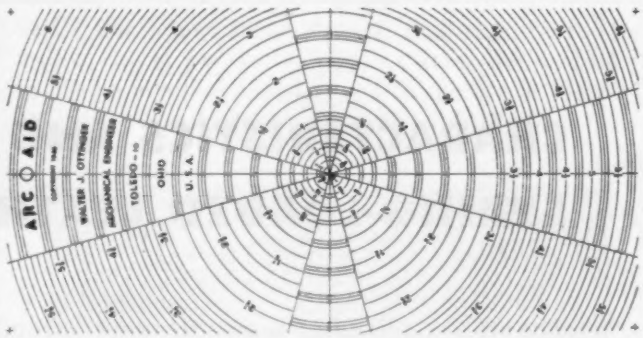
engineering dept equipment



from 1/8 to 6 inches, with 1/16-inch steps up to 1 inch, and 1/8-inch steps from 1 to 6¼ inches. Manufacturer: Walter J. Ottinger, 3256 Parkwood Ave., Toledo 10, Ohio.

For additional information circle MD 44 on Page 271

Nonmetallic Coatings

(*Concluded from Page 102*)

the resistance they must exhibit against corrosive influences which may affect machine or structural components. This subject is intimately bound up with the nature of the materials undergoing protection and the identity of the corrosive agents. The designer frequently must make a choice between an expensive corrosion-resistant alloy or a less expensive metal and a protective coating. In the latter situation the design requirements and coating properties are inseparable.

An unlimited number of situations may be drawn upon to illustrate the dependence of machine performance upon the efficacy of the coating. An example which has received much attention in recent years is the undercoating received by naval vessels to resist barnacles and other marine growths, the presence of which slows down the maximum speed. The inclusion of copper oxide and copper naphthenate compounds in the oleoresinous varnish formulations enabled coating manufacturers to achieve their objective. Hence, proper coatings will withstand sea water corrosion and marine growths and permit full operational efficiency of ocean-going vessels.

Protective value of nonmetallic coatings need not necessarily be applied to large machines to be dramatic, inasmuch as the protection of small components may be equally impressive. Selenium or copper oxide rectifiers, now utilized in the practical conversion of alternating to direct current, depend for operating efficiency upon the stability of circuit parameters under changing moisture conditions. Nonmetallic organic coatings are eminently suited to the fulfillment of these roles.

Relationship of nonmetallic coatings to machine design in these instances of weather and atmospheric protection may be described in the statement that the permanency of acceptable performance of a machine component is directly related to its resistance to prevailing corrosive influences.

Professional Viewpoints

". . . power required for coiling"

To the Editor:

In the past few months we have had the basic problem of calculating or estimating the driving power required for coiling or winding metal strip. In all cases the problem includes the determination of the tension of the material necessary to wind it into a good nontelescoping package.

We believe that the analysis of forces involved includes the spring-back of the material, the bending moments to deform the material into coil form and the frictional resistance between layers of the coil which prevent unwinding.

It would be very helpful to us to have the benefit of the experience of your readers in analyzing or estimating the coiling power and strip tension required for forming a good coil.

—Joseph H. Gepfert

". . . short approximate calculation of deflection."

To the Editor:

The article by Professor Kenneth E. Lofgren, "Calculating Deflection of Curved Beams," (Machine Design, November 1948) is interesting and valuable. However, the methods discussed consume considerable time in practical application, especially for beams with varying cross sections. It might, therefore, be worth while to point out the following short approximate calculation of the deflection of a curved beam as, for instance, presented in *Fig.* 14 of the article.

For a straight cantilever beam of *uniform* cross section, the deflection is:

$$\delta = \frac{C_1PL^3}{EI_o} = \frac{C_1M_{max}L^2}{EI_o}$$

where $C_1 = 1/3$.

For a straight cantilever beam with diminishing cross sections so that M_xI_x = constant, the deflection is:

$$\delta = \frac{C_2M_{max}L^2}{EI_o}$$

where $C_2 = \frac{1}{2}$.

For a straight cantilever beam with cross sections diminishing from I_o to I_p, the deflection is:

$$\delta = \frac{C_3M_{max}L^2}{EI_o}$$

where

$$C_3 = \frac{1}{2} - \frac{1}{6} \times \frac{I_p}{I_o}$$

interpolated from Equations 1 and 2 above.

The same deflection formula applies, with very close

Paradise *for* Designers

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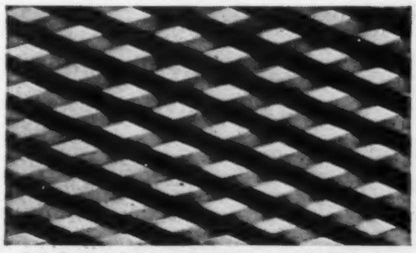
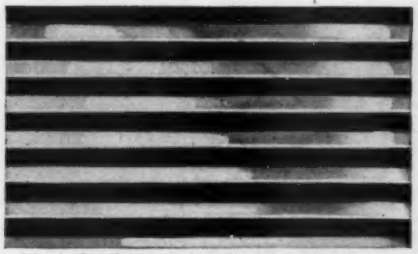
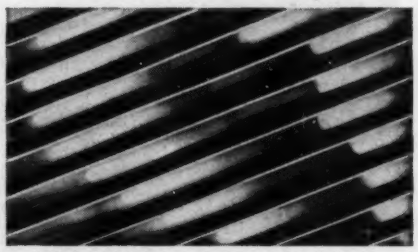
NICKELOID PRE-PLATED METALS SHOWN IN GREAT ARRAY OF PATTERNS, FINISHES



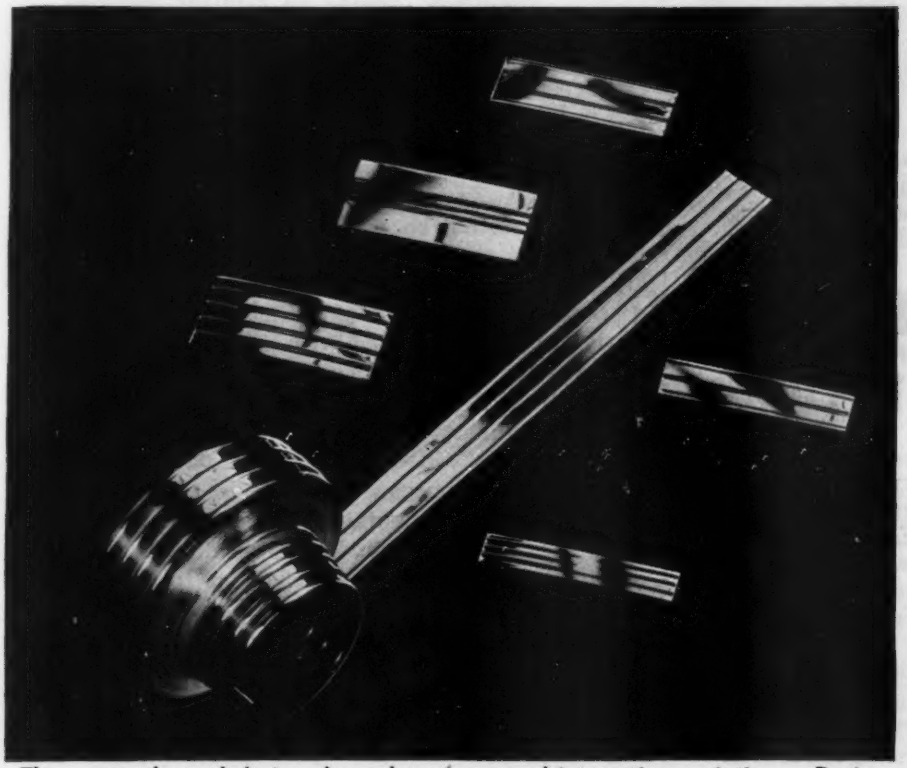
Nickeloid Metals Diamond Crimp



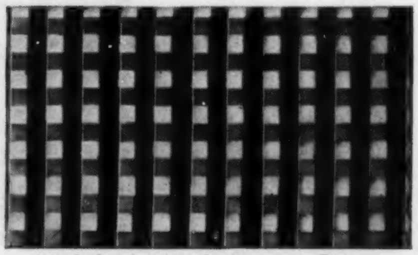
Nickeloid Metals Horizontal Crimp



Nickeloid Metals Diagonal Crimp



The new embossed design shown here in several interesting variations. Design can be embossed (raised) or intaglio (depressed).



Nickeloid Metals Square Crimp

Product designers need not be limited to the use of unrelieved bright surfaces of plated metals in adapting Nickeloid Metals to trim or functional use in their new designs. These metals are offered in various interesting stripes, crimps, and embossed designs.

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approximation, also to *curved* beams, M_{max} being the actual maximum bending moment and L the overall length of the centerline of the beam.

For instance, with numerical values of the example in *Fig.* 14, we get for the curved beam:

$$\delta = \left(\frac{1}{2} - \frac{1}{6} \times \frac{0.91}{3.5}\right)\left(\frac{1000 \times 12 \times (8 + 6.284)^2}{12 \times 10^6 \times 3.5}\right) = 0.0266$$

In an analogous manner, the end slope of the curved beam can be approximated as follows:

$$\theta = \frac{CM_{max}L}{EI_o}$$

where $C = 1 - \frac{1}{2}I_p/I_0$.

—H. HEIMANN
Research Engineer
Waldes Kohinoor, Inc.

". . . for beams having no straight portions"

To the Editor:

The remarks of Mr. Heimann are indeed interesting and there is no doubt that the approximate methods he suggests are in many cases quite adequate. Certainly, there appears to be no reason why any designer should not be able to quickly evaluate the deflection of a curved beam with satisfactory precision. Mr. Heimann's formulas are useful in estimating deflections where the straight portion of the beam is fairly large in comparison with the curved portion. It is also true that the longer the straight portion is with respect to the curved portion, the more nearly will the ordinary cantilever formula yield satisfactory results.

The author's purpose in choosing the proportions of *Fig.* 14 in the original article was merely to illustrate the various methods described, and for these proportions the simplified deflection formula works very well. However, in cases where there may be no straight portion at all, a more accurate method of calculating the deflection seems to be in order.

—KENNETH E. LOFGREN

Correction

IN THE article "Determining Recoil Loading", by Macon Fry, which was published on Pages 93 to 96 of the January issue of MACHINE DESIGN, a typographical error appears in Equation (a). This equation defines the maximum force on a machine-gun turret due to recoil. As published, π in the last term of the equation appeared in the denominator. It should have been in the numerator. as follows:

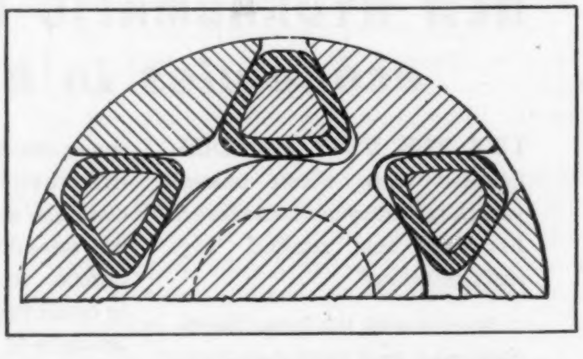
$$F = \pi \frac{U}{T_1} \csc\left(\frac{T_2\pi}{T_1}\right) \qquad \text{(a)}$$

The editors regret this error and sincerely hope it did not cause undue confusion in the minds of MACHINE DESIGN's readers.

Noteworthy Patents

PRECISION TIMING of starting and stopping two driven shafts, independently of one another, from a single drive shaft is provided by a self energizing multiple clutch covered in patent 2,443,491. Assigned to Automatic Instrument Co. by Lloyd J. Andres, the clutch utilizes a novel arrangement whereby only relatively small forces are required for engaging and disengaging in operation. Striker plates on the control shaft engage projections on the clutch and at timed intervals shift the power from one drive to the other or to neutral. The strikers can be positioned to strike in whatever sequence is desired.

ELIMINATING TORSIONAL VIBRATIONS in shafts forming a part of an elastic driving system, the elastic coupling covered in patent 2,446,942 and assigned to the Packard Motor Car Co. by Forest R. McFarland is designed to vary the elasticity of a rotational system through different operating speeds. A rubber-covered, metal inertia member is confined in a vee-shaped space between the dogs of a positive jaw type clutch. This inertia member shifts radially outward in response to centrifugal force, changing



the surface area of the rubber engaging the jaw sides and also the stiffness of the coupling between the driving and driven members. Thus, the stiffness of the connector is varied in proportion to the speed of rotation, changing the natural frequency of the rotational system throughout the speed range.

FRICTION COUPLING for portable power-driven tools such as screw drivers and nut-turning devices is covered in patent 2,446,363 granted to Edwin W. Daum and assigned to James Clark Jr. Electric Co. Eliminating the vibration and chatter usually found in hand power tools, the device utilizes a multiple-disk clutch between the driving member of the positive jaw clutch and the motor. When a screw or nut is tightened, the load on the motor increases up to the slip point of the disk clutch. At this point, the

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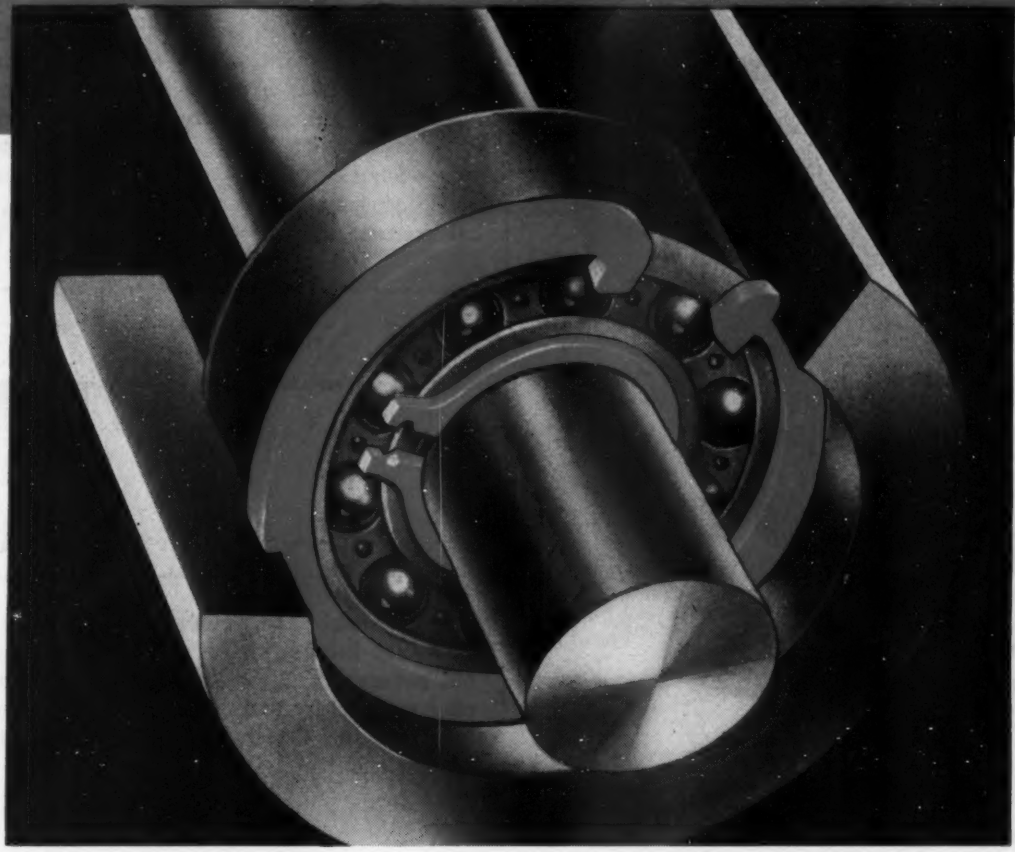

Examine the designs of **all** your products and machines. No doubt you can use retaining rings on axles and in housings – not **only to save assembly time, but to save weight, parts and space.**

The use of these inexpensive yet efficient artificial shoulders is already widespread, and is increasing daily.

There are literally thousands of places in which redesigning for retaining rings can increase your profits and improve your products – uses ranging from heavy duty engines and drill presses to toys, gadgets and small parts of innumerable articles.

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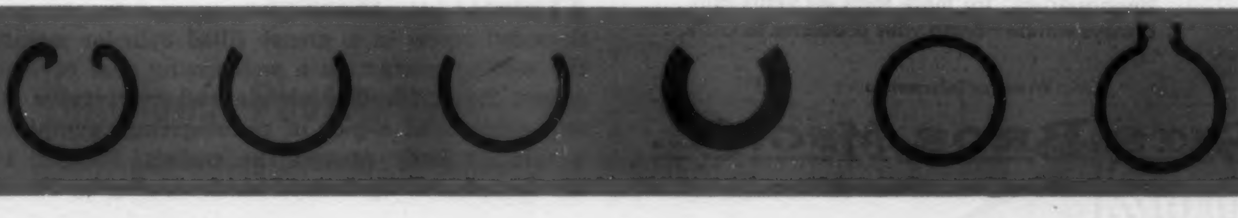
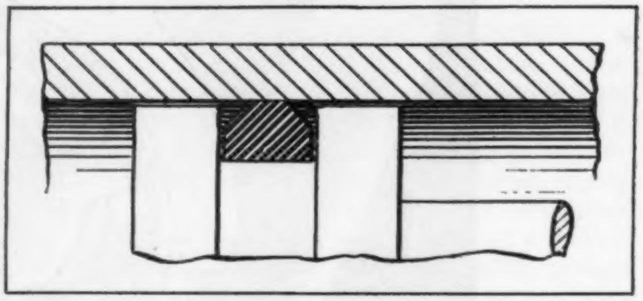


screw holds the driven disks against further rotation while the driving disks are permitted to turn smoothly and quietly. Slip point of the disk clutch is adjustable to permit handling of screws or nuts of different size.

SERVICE LIFE of O-ring seals, often drastically shortened by internal stresses set up during application or spiral failure due to uneven twisting in operation, is said to be greatly improved by a new ring design. Use of an octagonal cross section not only eliminates the difficulties encountered in molding a perfectly round cross section ring, but makes possible simple application by allowing the ring to be slid into place on its cylindrical surface without twisting. The design is said to obviate twisting in service and the ring remains stationary in its groove, the cylindrical contact surface presenting a wide, long-wearing



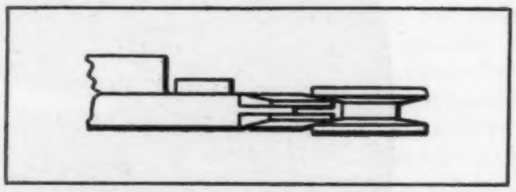
effective seal face. Slanting faces of the ring tend to assist lubrication of the wearing face, a feature not present in square or rectangular rings. Packing ring covered by patent 2,444,119 assigned to the Garlock Packing Co. by Frederick C. Thorn and Robert M. Waples.

LUBRICATION OF HIGH-SPEED BEARINGS is accomplished without application of shop air pressure with the device described in patent 2,447,671. To provide the mist or spray lubrication necessary in bearings rotating at 10,000 rpm or higher, a restricted opening in the passage from the oil reservoir permits a limited amount of oil to flow to an oil-slinger chamber. Oil vaporized by a shaft-mounted slinger is forced into the bearing chamber and bearing by the air currents created by the slinger. Westinghouse Electric Corp. has been assigned the patent by Raymond W. Schuck.

HYDRAULIC PRESSURE created by turning a threaded screw in a grease filled cylinder maintains the sealing contact in a well casing seal covered in patent 2,444,216. The simple and inexpensive static seal consists of a pair of packing rings contained in a retainer body around the casing. Packing rings are forced radially inward on the casing by the pres-

sure around their circumference. Provision is made for testing the seal by forcing a testing fluid into a grooved weep ring between the upper and lower seals. Inventors Herbert Allen and Madden T. Works have assigned the patent to Cameron Iron Works.

Friction drive, especially adapted for use on washing machine agitators, overcomes variations in drive characteristics due to slight variations in manufactured parts by employing one friction member with spring faces. In the case of washing machine drives



where reversal is desired, the drive can be designed so that the frictional driving engagement is limited to a specific central portion of a drive sector. In this manner smooth reversals are obtainable without "crawl" of the agitator about the axis of oscillation. Drive is covered by patent 2,444,017, assigned to Perkins Machine and Gear Co. by Hiram D. Croft.

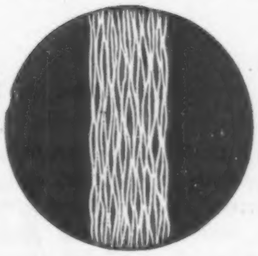
Superprecision Bearings

(*Concluded from Page* 126)

ment shown in *Fig.* 30 is much superior since both the cap and slinger can be machined for precision fits in the housing and on the shaft, respectively, avoiding the eccentricities of threaded members and allowing seal clearances to be held to the minimum.

The attachment of the cap to the housing merits careful attention. Where the cap merely contacts the housing face and is not required to contact the bearing face there is no particular problem in maintaining a tight joint. Gasket material may be used to avoid oil leakage where it is critical. However, in those cases where the fixed bearing is involved the cap must not only close the housing against dust or oil leakage, but must also clamp the bearing against the housing shoulder. In such cases, the leakage problem can be solved either by fitting each cap to avoid end clearance, or by using a compressible gasket washer or both. Housings may be made oil tight by means of the design shown in *Fig.* 31. At the fixed end, where the preloaded DB pair is locked endwise in the housing by the cap, a compressible Neoprene ring inserted in an annular groove in the housing keeps the joint tight even though the cap and housing do not exactly abut. Tightening the screws evenly will avoid cap distortion. At the opposite or floating end, *Fig.* 32, a simple gasket may be used as the cap need not and must not limit bearing end travel during temperature changes.

The application, fitting and removal of superprecision ball bearings will be covered in Part V of this series and will appear in the March issue of Machine Design.



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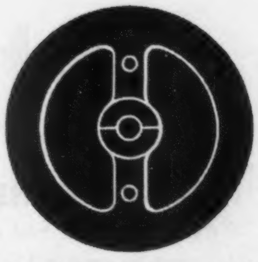

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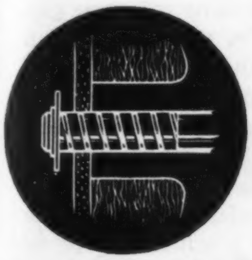

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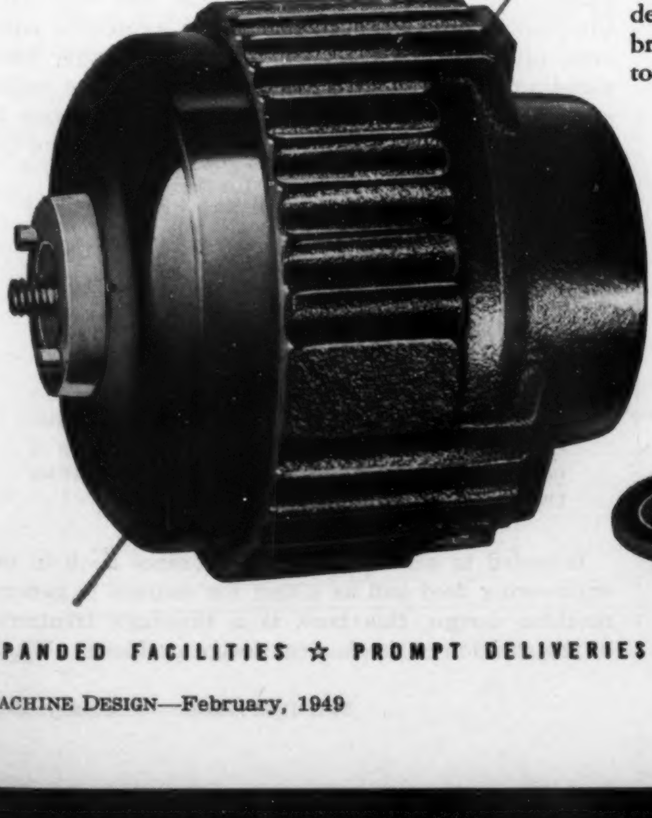

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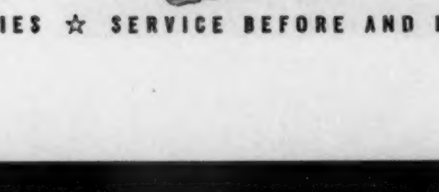

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Assets to a Bookcase

Mechanics of Machinery

By C. W. Ham, professor of machine design, University of Illinois, and E. J. Crane, Western Electric Co.; published by McGraw-Hill Book Co., New York; 538 pages, 6 by 9¼ inches, clothbound; available through* MACHINE DESIGN, *$5.00 postpaid.

The third edition of this book retains the same general arrangement of material as in the first two editions. Mechanism is treated in the first section, followed by kinematics and dynamics of machinery in the second part. Chapters on vibration, critical speeds of shafts and the gyroscope have been added, together with additional material on flywheels and governors. Except for the section on mechanisms, the presentation of the material presupposes a knowledge of analytical mechanics.

□ □ □

Engineering Materials

By Alfred H. White, professor emeritus of chemical engineering, University of Michigan; published by McGraw-Hill Book Co. Inc., New York; 686 pages, 6 by 9¼ inches, clothbound; available through* MACHINE DESIGN, *$6.00 postpaid.

The abnormally rapid development of new engineering materials in the recent war brought about the revision of this textbook on the behavior of materials. Light metals, plastics and synthetics have been, of course, the most publicized of these new materials. Chapters on alloy steels, light metals, protective coatings, plywoods and other laminates are either completely revised or entirely new. The various topics are presented with enough theoretical explanation to give the student or engineer an understanding of design materials.

□ □ □

Machine Design

By Paul H. Black, professor of machine design, Cornell University; published by McGraw-Hill Book Co., New York; 357 pages, 6 by 9 inches, clothbound; available through* MACHINE DESIGN, *$4.00 postpaid.

Intended to serve both as a reference book in the engineering field and as a text for courses in general machine design, this book is a thorough treatment of the solution of mechanical design problems. Wher-

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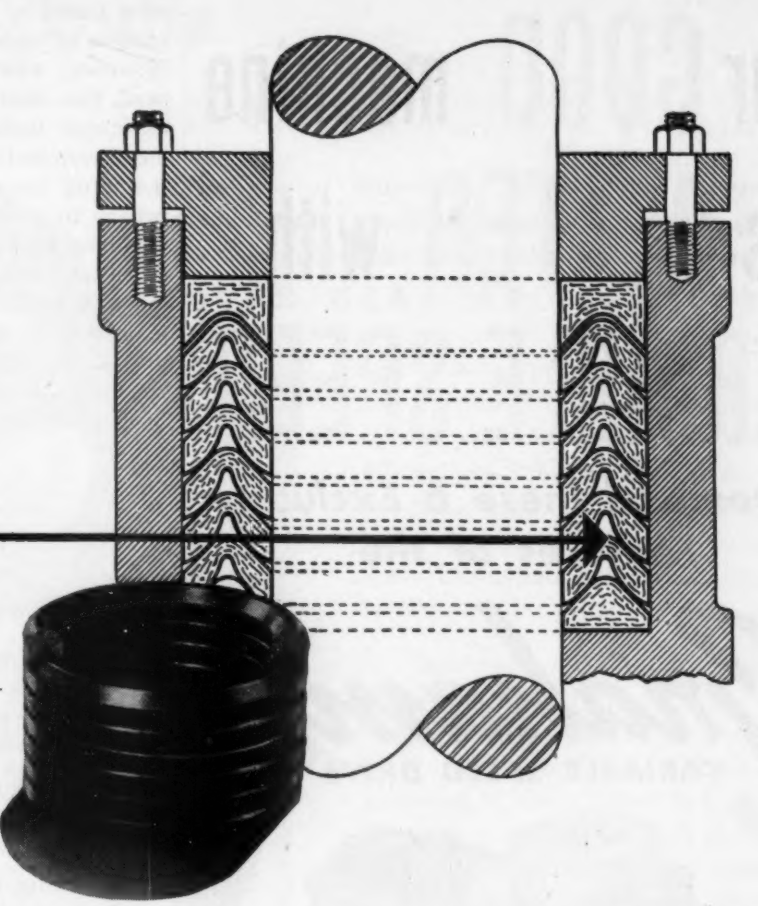

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ever possible, the analytical method combined with results of experimental investigation has been used. However, where analytical methods proved impractical, the empirical procedures are presented. Topics discussed include stress concentrations in machine members, methods of determining allowable stresses including the effect of surface finish, the design approach to gear problems, friction and wear of finished surfaces, lubrication of sliding bearings, vibration and vibration control together with methods of designing and selecting vibration-absorbing units, mechanical fabrication, and detachable fastenings. Generous use of photographs, drawings and charts to point up the various subjects discussed in the book add immeasurably to its value as an engineering reference.

□ □ □

The Dynamics of Automatic Control

By R. C. Oldenbourg and H. Sartorius, translated from German and edited by H. L. Mason, research professor of mechanical engineering, Iowa State College; published by the ASME, New York; 276 pages, 6 by 9¼ inches, clothbound; available through MACHINE DESIGN, *$7.50 postpaid.*

Presenting the German approach to mathematical analysis of automatic control problems, this book is a thorough treatment of the findings made in that country through the war years. The use of Laplace transforms and difference equations, and the practical usefulness of the results presented in graphical form should make the book valuable to the design engineer interested in automatic control. Necessary explanatory phrases have been added to the body of the text, technical and correlating footnotes have been provided, and the bibliography and subject index have been extended in an effort to make the translation clearer to the American reader.

A table is now available containing natural tangents for every second from 0 to 90 degrees. Designed to eliminate the need for interpolation, the 630-page, 6¾ by 10½-inch clothbound book *Natural Tangents* is obtainable from the publishers, Parker & Co., 241 E. 4th St., Los Angeles for $15.00.

The 1948 ASTM Standards on Copper and Copper Alloys, the 1948 edition of which has just been published includes 106 standard specifications, test methods, and definitions of terms. The copper and copper alloy specifications included cover wire and cable, conductors, plate, pipe, alloys for sand castings, and others. Expansion of tubing, preparing tension specimens, tension testing, resistivity, and Rockwell hardness are among the 11 methods of test presented. Copies of the 516-page book may be obtained from the ASTM Headquarters, 1916 Race St., Philadelphia; heavy paper cover, $4.35, or cloth binding, $5.00.

Pitch-Changing Mechanisms for Marine Propellers

(*Concluded from Page* 129)

War II and, more recently, in an articulated high-speed automobile carrier. A three-sided control rack meshes with teeth cut in the blade shanks to rotate the blades.

In the naval installations, the control rack shaft extends through the hollow propeller shaft to a cross-head, which is moved by a screw. The screw is driven by a reversible electric motor through two sets of planetary gears and a set of bevel gears. The blade spindle axis is skewed both transversely and fore and aft in order to obtain greater bearing lengths with a smaller hub size, and to balance both steady and centrifugal spindle moments in steady operating conditions. With this arrangement, however, transient control forces were high during pitch changing, and revolutions during quick reversals were restricted. No blade seals were employed in the naval applications, and the hubs were grease-lubricated. This caused some maintenance problems from bearing wear. The inherent backlash of a rack and gear system, as in a bevel gear system, is not considered desirable where the blade spindle torque components are nearly zero.

Reliability of Designs Proved

The controllable-pitch propeller is particularly desirable for all diesel craft which operate at varying loads. Reliability of various controllable-pitch mechanism designs has been proved for small vessels up to medium cargo-passenger types. Therefore, the author considers that controllable-pitch propeller applications in harbor tugs, fishing trawlers, and similar craft will increase rapidly and predominate in the future. With the additional advantages of improved maneuverability, moderate gains in fuel economy at reduced speed, less cost, weight, and lower transmission losses as compared to diesel-electric drive, it is considered that other types of diesel-powered vessels will seek increasing application of controllable-pitch propellers.

It is in the potential field of application to gas-turbine-powered vessels that the controllable-pitch propeller stands out. The inherent irreversibility of the prime mover and the difficulties of fitting large reverse gears or an astern turbine, as is generally done in steam installations, dictate extensive applications of controllable-pitch propellers in this field. Smaller space, weight and cost, as well as higher transmission efficiencies, favor controllable-pitch applications over either electric drive or the reversible hydraulic torque converter. In addition, the considerable fuel economy gains to be expected at reduced load operation balance the scale further in favor of controllable-pitch propellers for future marine gas-turbine installations.

Meetings and Expositions

Feb. 28-Mar. 4—

American Society for Testing Materials. Spring Meeting and committee week to be held at Edgewater Beach Hotel, Chicago. Robert J. Painter, 1916 Race St., Philadelphia 3, Pa., is assistant to the secretary.

Mar. 8-10—

Society of Automotive Engineers Inc. Passenger car, body, and production meeting to be held at Book-Cadillac Hotel, Detroit. John A. C. Warner, 29 West 39th St., New York 18, N. Y., is secretary and general manager.

Mar. 10-12—

American Society of Tool Engineers. Seventeenth annual meeting to be held at William Penn Hotel, Pittsburgh. H. E. Conrad, 10700 Puritan Ave., Detroit 21, Mich., is executive secretary.

Mar. 14-17—

Chicago Technical Societies Council. Seventh Chicago production show to be held at Stevens Hotel, Chicago. Additional information may be obtained from Edward C. Bowman, General Manager, 8 So. Michigan Ave., Chicago 3, Ill.

Mar. 28-30—

Society of Automotive Engineers Inc. Transportation meeting to be held at Statler Hotel, Cleveland. John A. C. Warner, 29 West 39th St., New York 18, N. Y., is secretary and general manager.

Apr. 11-12—

American Institute of Electrical Engineers. Conference on the industrial application of electron tubes to be held at Statler Hotel, Buffalo. H. H. Henline, 33 West 39th St., New York 18, N. Y., is secretary.

Apr. 11-13—

Society of Automotive Engineers Inc. Aeronautic and air transport meeting to be held at Hotel New Yorker, New York. John A. C. Warner, 29 West 39th St., New York 18, N. Y., is secretary and general manager.

Apr. 11-15—

American Society for Metals. Western metal congress and exposition to be held at Shrine Civic Auditorium, Los Angeles. W. H. Eisenman, 7301 Euclid Ave., Cleveland 3, Ohio, is secretary.

Apr. 18-20—

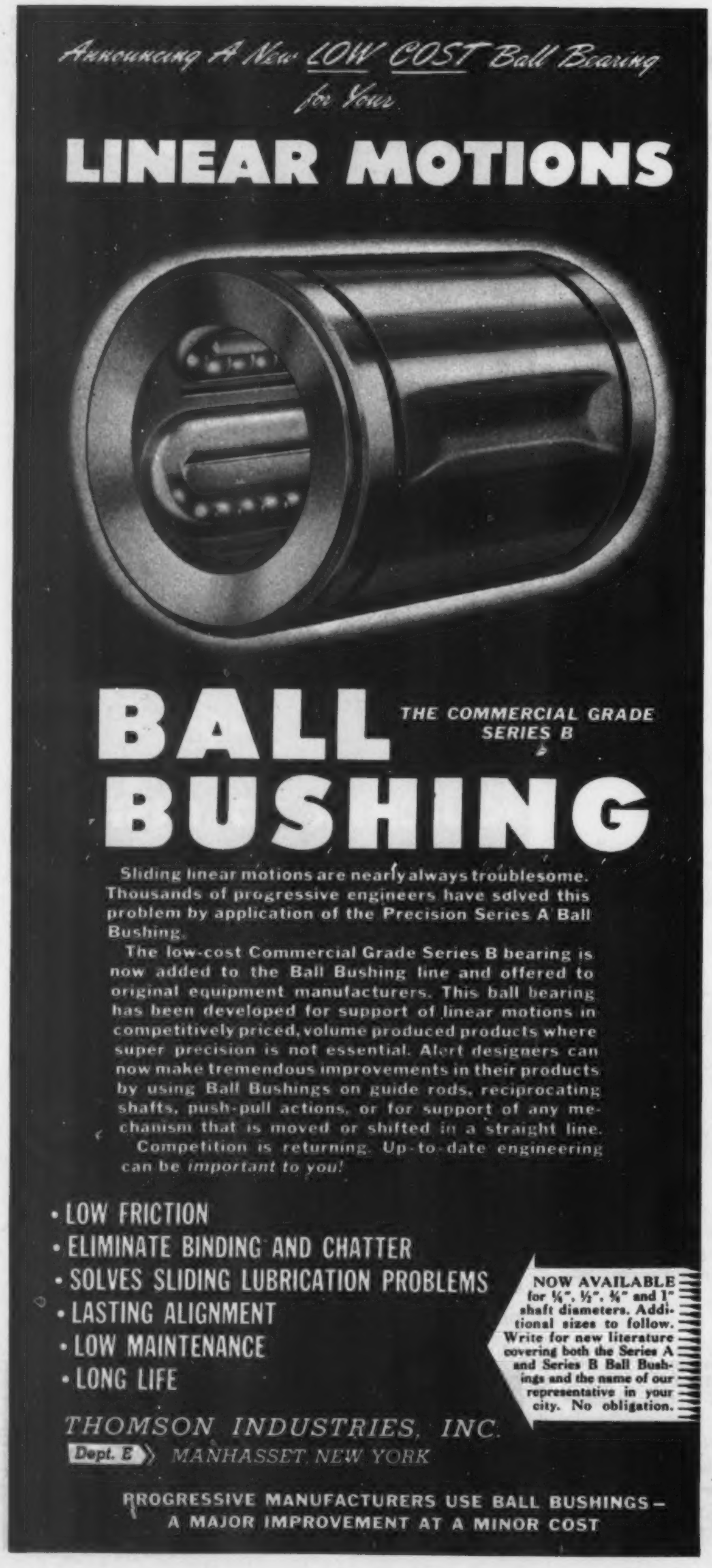
Midwest Power Conference sponsored by the Illinois Institute of Technology to be held at Sherman Hotel, Chicago. Dr. E. R. Whitehead, 3300 South Federal St., Chicago 16, Ill., is conference secretary.

Apr. 25-28—

Southern Machinery and Metals Exposition to be held at the Municipal Auditorium, Atlanta. Michael F. Wiedl, 267 E. Paces Ferry Road N.E., Atlanta 5, Ga., is managing director.

Apr. 25-29—

American Society of Mechanical Engineers. Oil and gas power division conference to be held at Hotel Sherman, Chicago. C. E. Davies, 29 West 39th St., New York 17, N. Y., is secretary.



Design Abstracts

Superspeed Flight Requires Superprotection for Pilots

TECHNICAL limitations on the speed of aircraft have not been reached. Future planes may well travel several thousand miles an hour, but the pilot must be able to withstand the physical stress which such speeds will bring. The bottleneck in high-speed flight may be the human being unless science finds ways to protect him from the forces created by the higher speeds.

There are four areas in biotechnology in which engineering and medical scientists are cooperating to push aircraft flight further beyond the speed of sound.

1. EXCESSIVE HEAT IN THE COCKPIT: Without cooling, the temperature at 670 miles per hour (the official world's speed record) would approximate 200 degrees Fahrenheit. The solution is refrigeration. In an attempt to approach "living room" conditions of temperature and pressure, scientists have developed a 16-pound unit which blows cold air on the pilot to keep him cool. The unit contains a small turbine with a rotor one and a half inches in diameter and weighing one-half ounce. It turns at 100,000 revolutions a minute.

2. BLACKING OUT: To study pilot black-outs, some laboratories have set up intricate centrifuge equipment utilizing the principle of the farm cream separator. No difficulty is encountered in the functioning of the mental processes when the speed remains constant, even though it may be as high as 1500 miles per hour. However, rapid acceleration or deceleration may cause blackouts. The problem is to protect the pilot, such as by inflated clothing, in such a way that he will not blackout from blood leaving the brain in a pull-out from a dive, or "red-out" from excessive blood being forced into the brain on an outside loop.

3. ESCAPE: Speeds are now so great that pilots can't climb out and slowly descend in a parachute. At high speeds, the tail structure would tear the pilot apart. German experiments during the war revealed that bail-outs were disastrous to pilots. At speeds of 500 miles per hour, the corners of their eyes and mouths were torn and their ears were literally

ripped off the sides of their heads.

To solve the escape problem, designers have built ejector seats in planes and pilots have been equipped with canopies to protect their heads. Human beings can withstand 25 times the pull of gravity on their bodies for one-tenth of a second, and that is long enough to get them out of the plane.

4. CRASH TROUBLE: In crashes, pilots may be subjected to forces of 40 to 50 times the pull of gravity. Cockpits are being designed in an attempt to lessen this danger. Scientific tests of the human body, mainly the bones, are necessary to determine what the pilot can withstand and what kind of equipment must be designed to protect him. Human bones can withstand a compressive stress of 23,000 pounds per square inch. That means they're one-fourth as strong as cast iron and twice as strong as hickory wood. It means people are tougher than we ordinarily think.

From an address by Dr. John T. Rettaliata, dean of engineering, Illinois Institute of Technology, presented at a meeting of the Chicago section of the Institute of Aeronautical Sciences.

How To Merit Better Personnel

TO RATE—and get—outstanding youngsters in engineering and research, an adequate pay rate is not the only requisite. There must also be proper equipment and, just as important, the prospect of security of employment. We must live down the record of dropping engineers from the payroll first when sales volume starts to skid. They need proof, if we are to get the good ones, that research and development will go on during future periods of depression. In the company dominated by long-range planning, these functions *must* go on as long as there is cash in the till.

Our company has finally awakened to the fact that there are four vital needs which will be met by success in rating and getting top quality in research and engineering youngsters. The first need is in our research department and in plant metallurgical departments. The second need is a flow of "right" personnel from the research department to operating positions. Here is proof of progress in this important by-product of research.

Thirdly, as time runs on and our future planning becomes more realistic, it is clear that all of us need

positive product improvements, and new products, each of which will take us into new sales markets. We need, for long-range security, new levels of quality.

Fourthly, if we foundrymen are to make progress in knowledge of customer needs, and in finding analyses to meet them, there must be metallurgical study of their needs, and continually improved process control to meet such needs.—*From an address by William B. Given, Jr., president of American Brake Shoe Co., presented at a meeting of the Gray Iron Founders Association.*

Boeing's 200-hp Gas Turbine

THE Boeing Model 502 gas turbine consists of a single-stage centrifugal compressor with two outlets, two constant-pressure burners, and a compressor driving turbine. This primary stage, or hot gas producer, has a rated speed of 36,000 rpm, and drives the accessories. The secondary or power output stage, consists of another turbine with a rated speed of 24,000 rpm, and a 9.6:1 reduction gear, giving a rated output speed of 2500 rpm. Speed of the primary stage is entirely regulated by the fuel flow, and the speed of the secondary stage is independently regulated by the load, and can be varied from stall to runaway or maximum safe speed.

Weight of the engine without accessories is approximately 150 pounds. Power output will vary between 100 and 200 bhp, depending on the endurance life expected. Rated specific fuel consumption will vary between 1.5 and 1.0 lb/bhp-hr depending on the rating and the degree of component refinement possible. The engine is consistently easy to start; it can develop rated power fifteen seconds after the start is initiated. It can accelerate very rapidly, going from idle, which is about 10,000 rpm, to full speed in five seconds. It is practically vibrationless if the rotating parts are accurately balanced; destructively rough if not.

Offers Greater Power

Model 502 provides considerably more excess power for acceleration than the reciprocating engine. In addition, it cannot be stalled. However, air consumption is very high, and large intake and exhaust friction losses are not tolerable. The author has not yet seen a clean solution to the compressor inlet noise problem. This silencing problem is es-

pecially difficult because of the large flow and the necessity for very low pressure drop. Idle fuel consumption is high, roughly one-fifth full power consumption. Furthermore, development cost is high.

But these problems will be solved, and it seems inescapable that the small gas turbine will be a better solution to many of our power applications than any we have now. If the fullest advantage is taken of the reduction in engine and installation weight possible through the use of a simple engine like the Model 502, many vehicle applications can be better solved even in the face of the current fuel consumption. Production costs are unknown, but it seems most reasonable that they will be less per horsepower than reciprocating engines. In addition, the prospects for future improvement through development are very good, both as to fuel consumption and power-weight ratio. Component refinement will pay off in both. Use of regenerative heat exchangers will pay off well in fuel consumption, at the expense of power-weight ratio. Doubling engine weight would reduce fuel consumption 25 per cent. This trend will be followed where fuel consumption is a primary consideration. Since regenerators are basically static structures, a design which properly takes care of thermal strains should be relatively inexpensive to build and maintain.—*From a paper by S. D. Hage, propulsion development unit chief, Boeing Airplane Co., presented at the recent annual meeting of the SAE in Detroit.*

Low-Tension Ignition System

IN THE last few years, considerable work has been conducted on ignition systems for the higher powered engines and the outstanding result has been the development of the low-tension ignition system. The basic difference between this system and the conventional high tension type is that only low potential impulses are generated by the magneto and these are transmitted, still at low voltage, through the distributor and harness direct to a set of induction coils mounted on the engine near the spark plugs. By transformer action, the voltage is stepped up and thence transmitted by short detachable leads to spark plugs.

An automatic spark advance mechanism is incorporated in each distributor. This device is centrifugally operated to advance or retard the spark as a function of engine rpm. During idle and high power opera-

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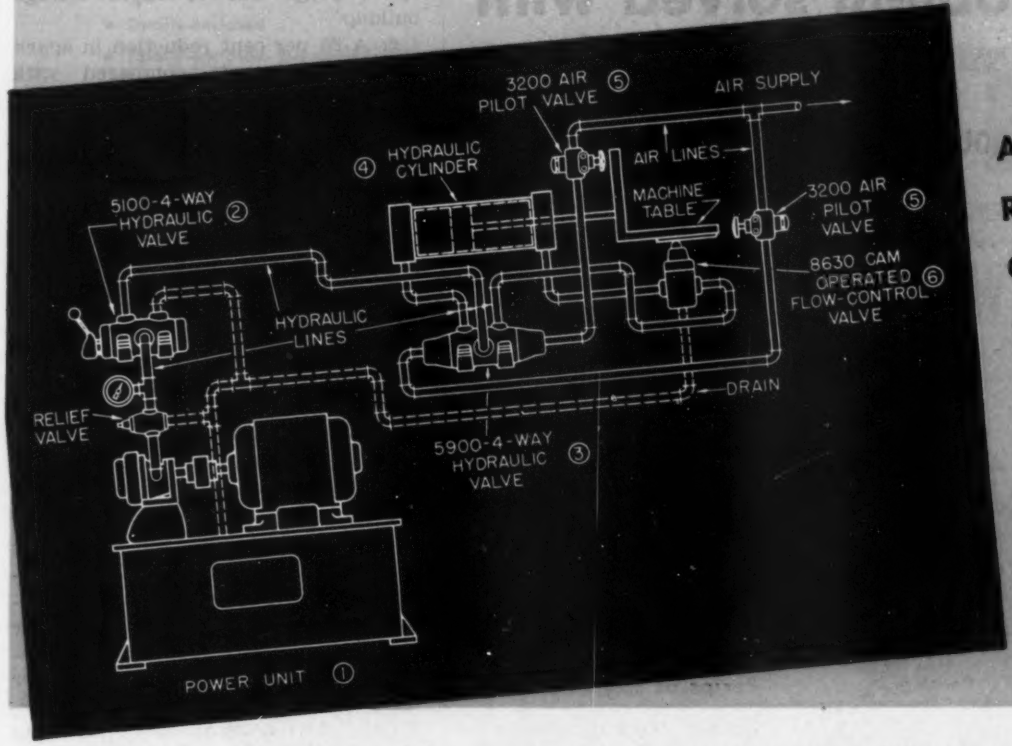

AUTOMATIC RECIPROCATING CIRCUIT FOR CONTROLLED FEED OF MACHINE TABLE

Shifting model 5100 (2) control valve allows oil from pump unit (1) to pass through model 5900 (3) pilot operated control valve to the blind end of cylinder (4), causing piston to move forward. As cam of model 8630 (6) flow control valve is depressed, the required rate of speed of forward stroke is obtained. When model 3200 (5) pilot valve is contacted, pilot pressure shifts model 5900 (3) pilot valve, and cylinder travel reverses. To stop table, shift model 5100 (2) control valve to original position and oil is by-passed to tank at zero pressure. Use cushioned cylinders when piston velocities and inertia of connected loads are high.

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1 EXPERIENCED DISTRIBUTORS
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air and hydraulic valves and cylinders; hydraulic pumps, pump units and hydraulic motors.

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tion, 20-degree btc timing is provided and in the cruise power range 30-degree btc timing is used to achieve an improvement of 3 to 5 per cent in fuel economy. Additional significant advantages obtainable with the low-tension system are as follows:

1. The low-tension system has greater ability to fire partially fouled spark plugs due to rapid voltage buildup

2. A 60 per cent reduction in spark plug erosion rate compared with that of a conventional high-tension system due to the low capacitance of the system.

3. Reduced radio interference difficulties, since the entire system except for the short high-tension leads operates at low voltage, and there are no high tension gaps other than at the spark plugs themselves

4. Low-tension wiring in the harness is not as vulnerable to temperature, oil, moisture, leakage, and mechanical chafing as the wiring in a high-tension system

5. The distributors incorporate a special set of breaker points for the booster circuit which is used in starting, thus permitting a retarded spark with resultant easier starts. In addition, since only low voltage is handled by the distributors, the danger of flash-over between adjacent electrodes is eliminated.—*From a paper by F. J. Wiegand and E. H. Olson, Wright Aeronautical Corp., presented at the recent annual meeting of SAE in Detroit.*

Modern Machine Styling

If a machine is reduced to its simplest functional form, it is conceded it will present a more pleasing appearance than in a less simplified arrangement of parts. Likewise the most pleasing shapes of the members of a machine will be those through which the functions of the machine will be performed with the best distribution of stresses and strains. The beauty of the human body is based upon the same principles.

In the general type of machine designed to perform a given function the parts are so shaped that they will transmit the forces and motions assigned to them with the least cost of material involved. This usually means designing the parts for minimum size. In designing this type of machine, which consists of little more than an assembly of skeleton links, little can be done toward improving the overall form except through sim-

plification of the mechanism. Oddly enough, the simplest mechanism which will accomplish the purpose for which the machine is designed will usually give the best impression or appearance.

When designing household equipment or machines in which an envelope conceals the working skeleton, the designer has an opportunity to improve the appearance of the machine by properly proportioning the shape of the envelope. With a little experimentation the designer will discover that some ratios of height to breadth of a rectangle will produce shapes which are satisfying and full of interest while other ratios are flat and without interest.

Use of the golden rectangle, whose long side is the root square of the short side, or of the root-five rectangle, will help keep the novice on the right track. A study of such books as Teague's "Design This Day", and Hambidge's "Elements of Dynamic Symmetry" will be of great assistance. A word of caution is in order. While one is modifying the form of the envelope it should be remembered that for truth of expression the outside should, in general, give a correct impression of the shape of the machine it conceals and should not contain a large vacant space not required in the functional operation of the machine just to produce an exterior of interesting shape. The design should express truth. If, as is often the case, the exterior surfaces are not in ideal proportions, they may be improved by breaking them up into areas of pleasing proportions by means of beads, incisions, or colors.

Keynote Is Simplicity

In designing machine housings and envelopes as well as the members of the machine mechanisms, remember this is an age of simplicity in design. The simpler the design the lower the cost of production. If the proportions are good and the effect is pleasing, why add embellishment which will complicate the design and increase the cost? If the designer is inclined to add bands, beads, or grooves for appearance's sake, he should critically examine his design with and without the ornamentation time and again to be sure the additions will increase the sale appeal of the article. The really great designer is one who can tell the most with the fewest lines and simplest shapes.—*From a paper by Earl D. Hay, Iowa State College, presented at the recent annual meeting of ASME.*

The almost uncanny efficiency and complete dependability of today's adding machine is a triumph of American ingenuity — and the result of sound engineering and design. The whirling gears and shafts and the lightning-like piston strokes that give accurate totals with amazing speed *are kept true and trouble free* in many of the popular makes, *with the help of Gramix bearings.* In the machine shown, six Gramix powdered-metal bearings — five bronze and one iron — perform faultlessly. Gramix bearings are die-pressed powdered metals that *require no costly machining and finishing.* Gramix parts are porous — retaining lubricant and releasing it only as required. They are tough and strong and operate with a minimum of noise and wear. Gramix gears, bearings, bushings and other machine parts may help you solve a production problem and save you money. Send us your prints for specific recommendations. *Ask for your copy of the 264-page Gramix catalog.*

GRAMIX

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DIVISION OF THE WICKES CORPORATION

Business and Sales Briefs

ACRO ELECTRIC CO., Cleveland manufacturer of snap action switches, has recently been purchased by a Pittsburgh group. Included among the new owners is Willard F. Rockwell Jr., president of the Rockwell Mfg. Co.

•

Appointment has recently been announced of Eugene T. Trace as northern Ohio representative of Palm, Fechteler & Co. He will have his office in Cleveland.

•

According to a recent announcement Raybestos-Manhattan Inc. has opened a warehouse and office in Seattle. Located at 314 Occidental Ave., the warehouse will carry a complete stock of industrial rubber products. At the same time, the company has announced the transfer of J. V. Bassett, former chief sales engineer of the heavy duty friction material division, to the equipment sales division at the Detroit headquarters.

•

Charles D. Eichorn has been appointed sales representative of the New York branch of the Berger Mfg. Div. of Republic Steel Corp.

•

Announcement has been made of the election of Robert F. Ohmer as president of both New Wrinkle Inc. and Chadeloid Corp. Mr. Ohmer was president of New Wrinkle Inc. from the formation of the company until 1942. Since the war he has been vice president in charge of administration of the Hydraulic Press Mfg. Co.

•

Pacific Coast division has been formed by Revere Copper and Brass Inc. Located in Los Angeles, the division will be managed by Wallace H. Hitchcock. Theodore F. Richardson has been appointed assistant sales manager for industrial sales.

•

Operations of the wire and cable divisions of the apparatus and the construction materials departments of General Electric Co. have been consolidated according to a recent announcement. B. F. Ilsley has been

appointed manager of the wire and cable division of the construction materials department which will now handle this division of sales.

♦

Formerly general manager in charge of sales of the Jessop Steel Co., Frank B. Rackley has been elected vice president in charge of sales. At the same time, E. E. Bradberry has been appointed assistant manager of sales in Chicago with offices at 332 S. Michigan Ave.

♦

Expansion of the Joseph T. Ryerson & Son plant in Chicago will provide 118,000 square feet of additional space.

♦

Four new representatives have been appointed by the Janette Mfg. Co. In the South Central area, G. R. Haley has been appointed, with offices at 3405 Milton St., Dallas, Texas, 701 M & M Bldg., Houston, Texas and 537 Carondelet St., New Orleans. In the west, L. R. Burnester is San Francisco representative with offices at 546 Howard St., while in Buffalo, Harry C. Glaser will represent the Janette Co. with offices at 1807 Elmwood Ave.

♦

New headquarters building at 273 Ferris Ave., White Plains, N. Y., has been completed by the All-State Welding Alloys Co. Inc.

♦

Associated with Bowser Inc. since 1925, F. S. Ehrman has been elected to the post of vice president and director of sales. Other changes in the organization include the appointment of L. J. Suelzer as manager of the Pittsburgh district office and Gerald J. Klopfenstein as assistant to the vice president and director of sales.

♦

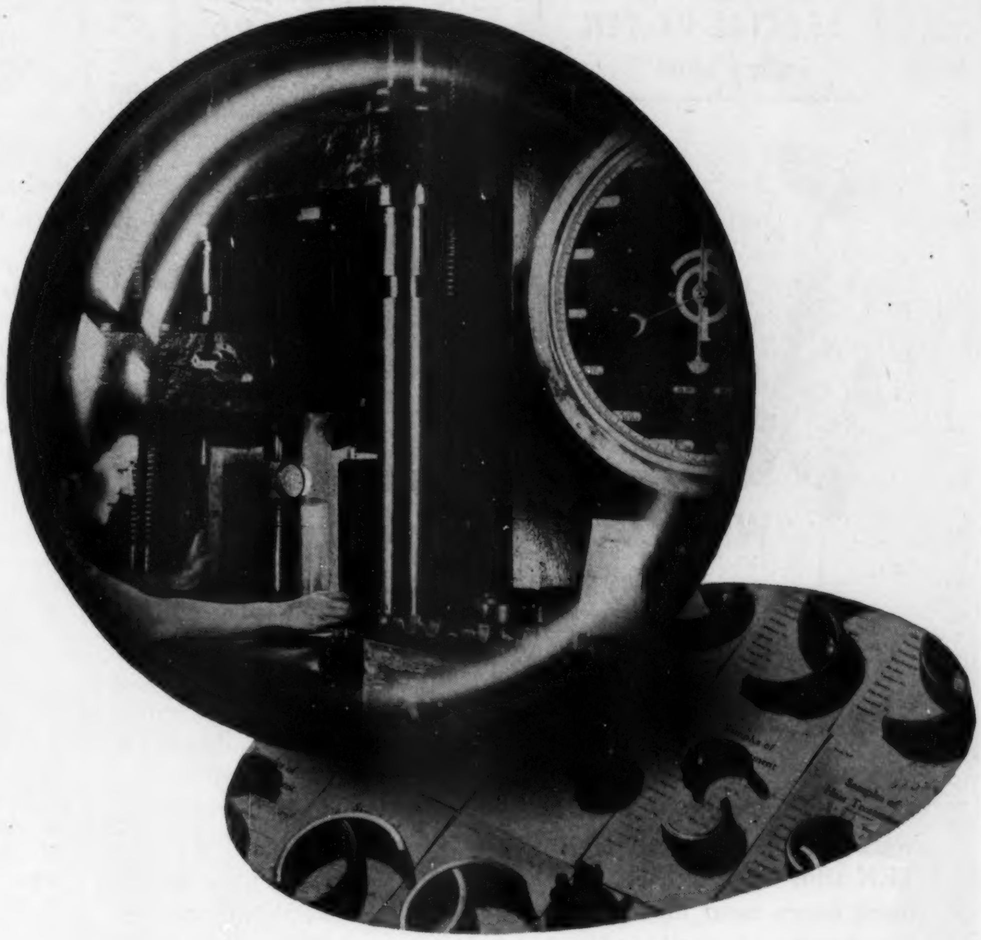
E. M. Ford has been named district manager of the Los Angeles territory for Penn Electric Switch Co., replacing W. H. Krack.

♦

A number of announcements have been made by the American Brake Shoe Co.: in the engineered castings division, N. George Belury has been elected president and Philip H. Clapp Jr. has been appointed sales manager. Maynard B. Terry has been elected vice president of the American Brakeblok division, and James J. Nelson has been appointed eastern sales manager of the National Bearing division.

♦

Previously with the Keystone Bolt and Nut Corp., M. J. L. Schulte has



Fractured for safety

These bearing parts are part of a day's vital statistics in Federal's "bureau of standards." Here race rings and balls are crush-tested after hardening to determine their load bearing strength, etch tested for any minute cracks in the fracture and Rockwell checked for hardness.

Conditioning a Federal Ball Bearing to deliver the right degree of resilience, toughness and resistance to compression and distortion starts with hardening the race rings *right through to the core* to withstand the severe pressure of the ball on the ball track, particularly under heavy load. Automatic electric controls insure a uniform heat-treat throughout the entire Federal hardening cycle. The silky fracture tells the "inside" story in inspection; performance proves it.

Every fourth operator is an inspector at Federal during the more than 100 individual manufacturing, inspection and cleaning operations that go into every Federal Bearing.

There's a size and type that fits your application in the Federal line. Our Catalogue "K" describes them all. May we send you a copy?

THE FEDERAL BEARINGS CO., INC. • POUGHKEEPSIE, NEW YORK

Makers of Fine Ball Bearings

REPRESENTATIVES LOCATED AT
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402 Swetland Bldg., Cleveland 15, Ohio
8 South Michigan Avenue, Chicago 3, Illinois

FEDERAL BALL BEARINGS

ONE OF AMERICA'S LEADING BALL BEARING MANUFACTURERS

been appointed general sales manager of Stow Mfg. Co.

♦

Name of the Spencer Thermostat Co. has recently been changed. Formerly operated as a wholly owned subsidiary of Metals & Controls Corp., the company will now be known as Spencer Thermostat Div., Metals & Controls Corp.

♦

The election of Herbert E. Smith to the post of chairman of the board and chief executive officer of the United States Rubber Co. has been announced. Mr. Smith will be succeeded as president of the company by Harry E. Humphreys Jr.

♦

Three new distributors will handle the Ampco line of welding electrodes. They are Allied Weld-Craft Inc., 401 W. South St., Indianapolis; Arizona Welding Equipment Co., 815 E. Broadway, Tuscon, Arizona; and Welder Service Co., 2037-41 Canton St., Toledo.

♦

Appointment has been announced of Carroll Edgar as a representative of Kennametal Inc. in the Seattle area. Mr. Edgar's headquarters will be at 2727 First Ave., South.

♦

Cleveland office has been opened by Kinney Mfg. Co. Located at 202 Plymouth Bldg., 2036 E. 22nd St., the office will be under the supervision of William B. Mills, formerly of the Boston and Chicago offices.

♦

Previously vice president of the Ocean City Mfg. Co., McMillan Robinson has been appointed sales manager of the Metal Products division of Koppers Co. Inc. This newly organized division manufactures couplings, airplane propellers, piston rings and other industrial components.

♦

Indianapolis sales office of Cutler-Hammer Inc. has moved to 644 E. Maple Rd. New offices provide expanded facilities.

♦

At a recent meeting of the board of directors of the Adamas Carbide Corp., Edward L. Dreyer was elected vice president. Mr. Dreyer will be in charge of sales and advertising.

♦

New business offices of Aerol Co. are located at 2820 Ontario St., Bur-


8 MODERN FOUNDRIES
(Coast-to-Coast Service)
PLUS The 1949 advantages of Aluminum Castings by Alcoa
Compare the cost of finished products when you think of castings by Alcoa! Held to close tolerances, they require minimum finishing from as-cast. And their light weight means lower handling costs through your production line.
Alcoa produces sand, permanent, and semi-permanent mold castings. For more information and a prompt quotation, call your nearby Alcoa sales office (branches in 55 cities) or write ALUMINUM COMPANY OF AMERICA, 675 Gulf Bldg., Pittsburgh 19, Pa.
Sand and Permanent-mold Foundries at Bridgeport, Conn., Cleveland, Detroit, Los Angeles
ALUMINUM CASTINGS by ALCOA

bank, Calif. This organization was recently purchased by Airquipment Co.

♦

Succeeding F. V. Sams, who is retiring, J. H. Burrus has been promoted from assistant manager to manager of the Allis-Chalmers Portland, Oreg., district. Another recent promotion has been that of Robert L. Halsted to manager of the Cleveland district office.

♦

The investment casting facilities of Precise Castings Corp., have been purchased by Arwood Precision Casting Corp. The acquisition doubles the investment casting facilities of the Arwood organization.

♦

Announcement has been made of the appointment of Leo B. Grant as manager of the New York office of the Dow Chemical Co. Mr. Grant succeeds Ralph E. Dorland who died in May of 1948.

♦

Vickers Electric Div. of Vickers Inc. has moved to new quarters at 1815 Locust St., St. Louis 3. This move is concurrent with the expansion of their line of electric controls.

♦

Appointed distributors of Goodyear Pliobond adhesive, W. J. Ruscoe and Co. has its office at 2170 W. Market St., Akron.

♦

Formerly vice president of the Well Equipment Mfg. Co., G. R. Winder has been elected vice president and sales manager of the Chiksan Co. He replaces L. J. Laird who resigned from Chiksan in January.

♦

Change in name has been announced by the F. A. Smith Mfg. Co. Inc. The new name, Fasco Industries Inc., is intended to bring the corporated title into closer conformity with the trademark.

♦

The J. M. Cranz Co. has been appointed distributor of O-rings manufactured by the Parker Appliance Co.

♦

Two additional sales representatives have been appointed by the L. G. S. Spring Clutch Corp. They are: L. R. Twyman & Assoc., Fisher Bldg., Detroit 2; and Van Riper Engineering Inc., 4 Station Square, Rutherford, N. J.

♦

Opening has been announced of what is believed to be the first com-

Speed Production and Cut Costs with OSTUCO "tailor-made" tubing

No matter what your product, there's a good chance you can make it faster, better and at lower cost by using OSTUCO "tailor-made" tubing. OSTUCO prefabricates tubing to your exact blueprint requirements . . . eliminates from your production problems all threading, angle cutting, shaping, flattening and many other operations which can be performed most efficiently and economically on our fast, modern machines. This enables you to more profitably concentrate your efforts on assembly and other phases of manufacture . . . strengthens your competitive position through increased output and wider profit margin. Write direct or to our nearest Sales Office for free booklet "OSTUCO Tubing and Facilities."

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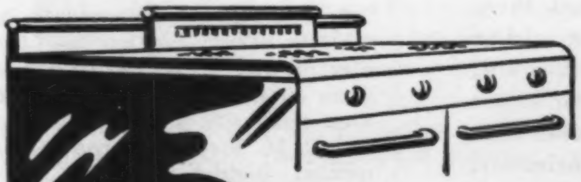
KITCHEN RANGES

Slash production costs and increase the beauty and practicality of your door handles by using steel tubing—Ostuco tubing fabricated to your own specifications. Ostuco will cut, burr, bend, expand, and roll the ends, and deliver the tubing in insert assembly, relieving you of many bothersome production details and increasing the sales appeal of your ranges.



LAWN CARTS

Save time, save labor, save money by having your tubing delivered all ready for assembly. Bending, flattening, drilling, external beading—all of these complicated forming and fabricating operations are handled in fast, mass production at Ostuco, thus providing you with short cuts to higher volume and lower cost.

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pletely equipped plastics laboratory available to industry for testing and development. Located at Hoboken, N. J., the laboratory is part of the facilities of the United States Testing Co.

♦

Frank E. Early has been appointed Detroit representative of the Askania Regulator Co. His offices will be located at 15234 Michigan Ave.

♦

New sales manager of glues and industrial resins for the Plaskon Div. of Libbey-Owens-Ford Glass Co. is Charles L. Neely.

♦

Until recently president of the Winter Brothers Co., John L. Cook has been elected president of the National Machine Products Co. of Detroit.

♦

Atlanta warehouse at 878 Ashby St., N. W. has been established by the Chain Belt Co. The new warehouse will be under the supervision of G. J. Schuelke, while the Atlanta district offices located at the same address will be under the direction of J. S. Moore.

♦

According to a recent announcement, Russell L. Jessee has been appointed Central States sales manager for Gedney Electric Co., with headquarters in Chicago.

♦

District offices of the Pittsburgh Equitable Meter and Nordstrom Valve divisions of the Rockwell Mfg. Co. are now located at 25 Beale St., San Francisco 5 and 1102 Delano St., Houston, Tex., respectively.

♦

Several sales appointments have recently been made by the Lincoln Electric Co.: C. W. Lytton has been made district manager of the Buffalo area with offices at 1700 Niagara St.; C. M. Richardson has been appointed district manager of the northwestern Pennsylvania district with offices at 741 Liberty St., Franklin, Pa. In Toledo, Ray Zeh has been appointed district manager. His office is at 663 Spitzer Bldg.

♦

Manufacture of all cellulose-nitrate plastic products has been discontinued by Celanese Corp. of America. Future activities of the plastics divisions are to be concentrated in the fields of cellulose acetate, cellulose

propionate and materials now in the development stage.

•

At a recent meeting of the board of directors of Jack & Heintz Precision Industries, Frank R. Kohnstamm was elected senior vice president. Mr. Kohnstamm joined the company in October, 1947, as general sales manager.

•

Appointment of the firm of Ehret & Kinsey, Chicago, as sales representatives has been announced by American Flexible Coupling Co. The new representatives are located at 327 S. LaSalle St.

•

The Progressive Welder Sales Co. of Ohio has been organized to sell resistance welding equipment in Eastern Ohio, western Maryland, western Pennsylvania and the northern section of West Virginia. With headquarters at 5713 Euclid Ave., Cleveland, the organization is headed by Ernest H. Lauter and George Omelianoff.

•

Formerly general manager of the Atlas Mineral Products Co., A. M. Younger has been appointed manager of Southwestern sales for Wolverine Tube Div., of Calumet and Hecla Consolidated Copper Co.

•

The Penn Rivet and Machine Co., formerly Penn Rivet Corp., has changed its corporate name to the Milford Rivet & Machine Co., Penn Division. Concurrently, announcement has been made of the election of James A. Sharkey as vice president in charge of sales and advertising, with offices in the N. B. C. Bldg., Cleveland.

•

Harry Crump has been named assistant to the sales manager of Carboloy Co. Inc.

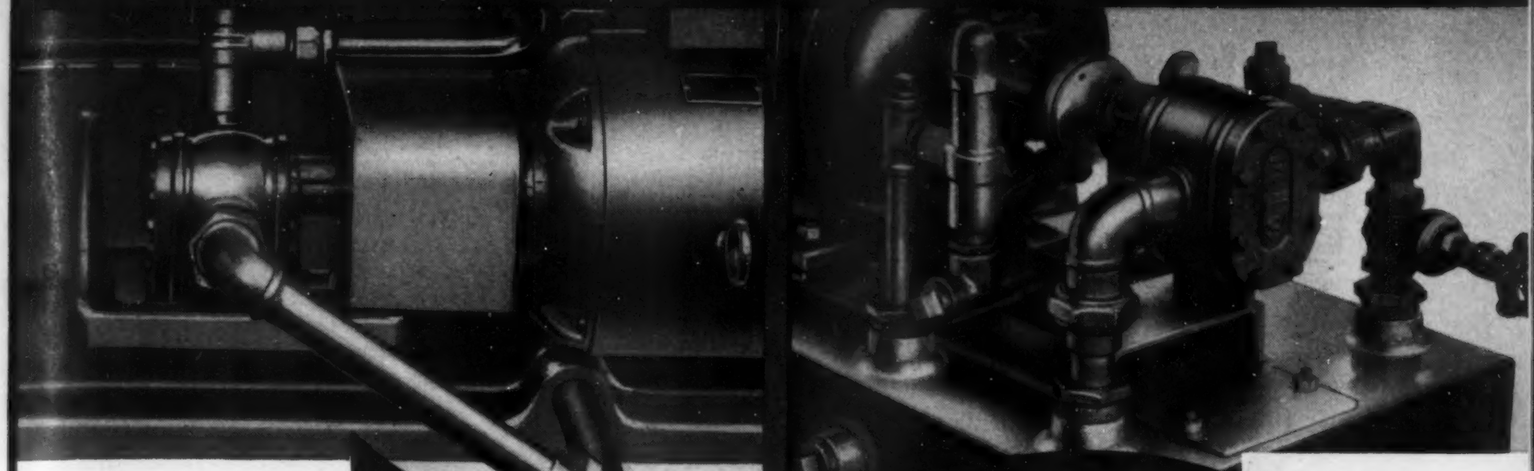
•

Formation of the Industrial Parts division of the Reynolds Metals Co. has been announced. This division, under the supervision of A. W. Pingel, will provide facilities for the manufacture of aluminum parts and components.

•

According to a recent announcement, Claude M. Lamb has been appointed to the new position of sales

RIGHT in their element . . .
ON HYDRAULIC SYSTEMS



Brown & Sharpe pump as standard equipment for hydraulic operation of machine tool.

BROWN & SHARPE Rotary Geared PUMPS

Compact installation of Brown & Sharpe pump for hydraulic operation of stoker unit.

For pressures up to 100 lbs. p.s.i. . . . **NOS. 1S, 2S and 3S ROTARY GEARED PUMPS** with helical gears. Self-lubricating.

For pressures up to 200 lbs. p.s.i. . . . **NOS. 53 and 55 ROTARY GEARED PUMPS** with roller bearings and helical gears.

For pressures up to 500 lbs. p.s.i. . . . **500 SERIES ROTARY GEARED PUMPS**—six sizes—with Herringbone Gears. Needle bearings, ground joints, alloy steel shafts, reversible back drain for reversing rotation. All moving parts balanced hydraulically . . . the 4 larger sizes, are balanced mechanically also. Foot-type mounting brackets available to meet practically any mounting condition.

Because these rotary geared pumps are specifically designed for hydraulic service, their features show up to advantage in daily operation. They are simple, compact, dependable and quiet. Their gears are made with extreme accuracy . . . to standards that characterize Brown & Sharpe machines and equipment. All have a mechanical seal designed to prevent leakage and eliminate gland adjustments. Everything about these pumps . . . design, materials, and manufacturing . . . is the result of long experience in meeting pump requirements for machine tools and other machine equipment.

Thousands of these pumps in daily service are giving performance that proves they are RIGHT in their element on hydraulic systems. Get complete information and specifications. Write for Pump Bulletin. Brown & Sharpe Mfg. Co., Providence 1, R. I., U. S. A.

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We urge buying through the Distributor

BROWN & SHARPE PUMPS BS

manager, Industrial V-Belt division and assistant to the vice president in charge of mechanical sales of the Dayton Rubber Co.

♦

Two new offices have been opened by the Clearprint Paper Co. The Chicago branch is at 20 E. Jackson Blvd., and the New York branch office is at 505 Fifth Ave. These offices are under the supervision of H. Henry and N. Heiman, respectively.

♦

Westinghouse Electric Corp. has announced the appointment of Leonard H. Loufek as industrial manager of the central district. Mr. Loufek succeeds C. H. Weaver who has been named manager of the company's atomic power division.

♦

Appointed Colorado representative for the Babcock & Wilcox Tube Co., Lewis B. Kinney will maintain offices at 1728 Stout St., Denver.

♦

Main office and manufacturing plant of Sound Apparatus Co. have been consolidated at Stirling, N. J. Previously located in New York, the organization will shortly appoint a sales representative for that area.

♦

Formerly regional West Coast manager of All-State Welding Co., Herman C. Phelps has been appointed sales manager. He is now located at the main office of the company, in White Plains, N. Y.

♦

The organization C. M. Murray Ltd. has been appointed Hydro-Line representative in the Provinces of Quebec and Ontario.

♦

Change of name has been announced by the Columbia Radiator Co. Now to be known as Columbia Foundry Co., the organization will withdraw entirely from the heating unit business and concentrate on the production of gray iron castings.

♦

Appointment has been announced of Lionel Tinfow as New York sales engineer for the Pennsylvania Flexible Metallic Tubing Co.

♦

The Nilson Engineering Co., 101 Washington St., Salem, Mass., has been named representative of Air-

matic Valve Inc. in the six New England states.

♦

Chicago office of Plastic and Rubber Products Inc. has been moved to larger quarters at 400 W. Madison St. The office is under the direction of Robert E. Allen, vice president in charge of sales.

♦

According to a recent announcement, James B. Holland II, has been appointed sales manager of the Taylor Fibre Co.

♦

Formerly in charge of export sales of Hill engines, Herman B. Robbins has been appointed manager of the Hill Diesel Engine Div. of Drake America Corp. Mr. Robbins will take charge of all sales activities of the division.

♦

With offices at Cedarburg, Wis., J. H. Park has recently been appointed sales manager of Electro Machines Inc.

♦

Associated with the Ahlberg Bearing Co. for 22 years, M. G. McGregor has been named to the post of sales manager of that organization.

♦

Manufacturers Sales Agency, 523 Brushton Ave., Pittsburgh 21, has been appointed sales agent for Titeflex in western Pennsylvania and West Virginia. Lewis Detch is manager of the newly appointed agency.

♦

Several new appointments have been made in the Syntron company's sales organization: Mark Chisholm has been appointed district sales manager of the newly established sales office in Des Moines, Iowa; Ernest K. Hood is now district sales manager of the new Kansas City, Mo., office; and R. K. Bentzien has been added to the Milwaukee sales staff.

♦

Expanded plastics manufacturing facilities have enabled Bakelite Corp. to increase average productive capacity by 60 per cent during 1948.

♦

Formerly head of Foote Bros. aircraft quality division, J. Gordon Knapp has become a member of the firm of Palma-Knapp Assoc., designers.

♦

Sprague Electric Co. has acquired the Herlec Corp. of Milwaukee, manufacturers of ceramic capacitors and printed circuits.

New Machines

And the Companies Behind Them

Business Equipment

DICTATION MACHINE. Disk "Voicewriter" uses 7-in. vinylite records for 30 min of dictation. Light enough to mail for 3 cents. Warning light blinks if no disk is in machine, if cover is not in place, or if instrument is not set on dictation. Disks can be erased by spinning while at high temperatures. Thomas A. Edison Inc., West Orange, N. J.

SOUND PROJECTOR. Sound and silent speeds for 16 mm film. Projector size, 7½ by 9½ by 15 in. Holds 2000 ft reels, has F 1.6 coated lens. Includes 6½-in. P. M. speaker built into carrying case, 1000 or 750 watt lamp. Forway Corp., N. Y.

Commercial

CONTAINER CLEANER. Belt conveyor type wash and rinse machine for cleaning tote pans, boxes or food containers. Automatic. Available in several sizes depending on capacity needed, heat required, etc. Cincinnati Cleaning and Finishing Machinery Co., Ironton, Ohio.

WINDOW FAN. Portable. For home or industrial use. Direct drive, 3-speed units fit window openings from 25 to 36 in. 16-in. fan delivers 1550 cfm; 20-in. model delivers 2100 cfm. Chelsea Fan & Blower Co. Inc., Irvington, N. J.

HUMIDIFIER. For areas over 2500 cubic feet. Vaporizes about ½-gal per hr. Automatic control holds desired humidity. Height, 10½ in.; diameter, 13½ in. Abbeon Supply Co., Woodside, N. Y.

Domestic

AUTOMATIC WASHING MACHINE. Permits selection of quantity and temperature of water by operator. Max hot water required for 8-lb wash, 16 gal. Only 5 gal needed for small loads. Any phase of automatic cycle can be interrupted, skipped or repeated. Requires 30 min to wash and spin dry full load. Rinse cycle includes warm spray, cold spray, and deep overflow. Hotpoint Inc., Chicago.

EVAPORATIVE COOLER. Installed in any type window opening. Disperses 800 cu ft filtered, washed and cooled air per min through 10-in. grill opening. Rubber mounted motor drives 4-blade fan. Palmer Manufacturing Corp., Phoenix, Ariz.

VACUUM CLEANER. Dirt picked up by suction unit combined with water, flushed down sink drain. Flexible,

accordion-like rubber hose capable of stretching to 5 times original length connects suction attachment to disposal unit at sink. Replaceable nylon screen in disposal unit catches solid matter that might clog drain. Hydroway Inc., Philadelphia.

WARM AIR CONDITIONER. Supplies domestic hot water and regulates humidity automatically. Burner has twin turbojet head delivering 120,000 Btu's at register. Unit 20 by 48 by 57 in. can be installed in 4 to 9-room homes. Carter Craft Corp., Thompsonville, Conn.

Industrial

HEATING TORCH. Suitable for most soldering, brazing and heating operations. Self-contained, requires no hose or tanks. Filling cost of less than 2 cents, 8-hr burning time. Operating flame 3800 F. Unit has pressure capacity of 2200 psi, operating pressure of 90 to 150 psi. Length, 12 in.; diameter, 2¼ in.; weight when full, 2½ lb. Sully Engineering Ltd., Beverly Hills, Calif.

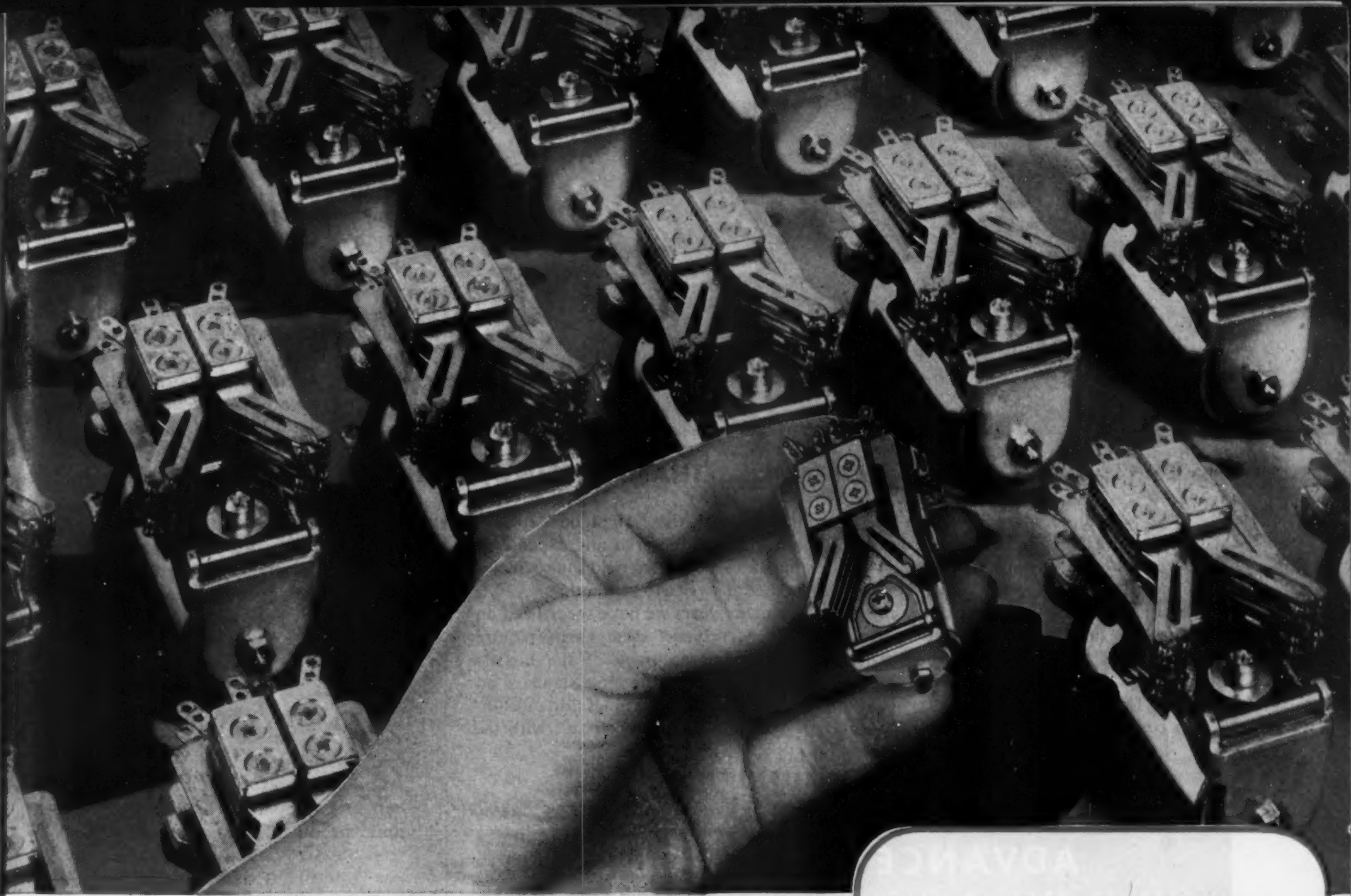
DUST COLLECTOR. Portable, self-contained. For handling dusts and toxic fumes from cutting, grinding, polishing or other operations. Unit consists of self-clearing paddle-wheel fan and cyclone separator, with connection to outdoors. Capacity, 2300 cfm at 8600 fpm air velocity, 4½-in. static suction, and 7-in. pipe. Aget-Detroit Co., Ann Arbor, Mich.

COMBINATION INDUSTRIAL BURNER. Convertible from gas to oil, or vice versa, in about 10 minutes. Switching from one fuel to the other requires interchanging burners in firing tube, connecting proper fuel line, attaching ignition and flame failure control wires, and setting fuel selector. Heat output capacities range from 400,000 to 2 million Btu per hour. Dravo Corp., Pittsburgh.

INDUSTRIAL GAS BURNER. Complete unit contains blower, burner, mixer, safety equipment, valves, regulator, and piping and wiring. Automatic. Electronic type flame failure unit closes main solenoid valve in event of pilot flame failure. Suitable for steam boilers and water heaters, industrial ovens or air heaters. Eclipse Fuel Engineering Co., Rockford, Ill.

Manufacturing

PISTON CHECKER. Simultaneously checks 11 critical dimensions and determines one of 5 skirt diameter classifications of diesel pistons. Interchanging gaging points permits checking of any of 13 pistons in 3¼ to 4¾-in. diameter group. Master light shows when all dimensions



are within specified tolerances. Individual lights show which dimensions are over or under. Sheffield Corp., Dayton, Ohio.

POWDER METAL PRESS. Cam type. Max depth of fill, 8 in., max diameter of piece, 4 in. Clutch and brake allow flywheel to come up to speed before engaging, lessening load on motor and allowing use of smaller motor. Press core rods will take 15 tons as movable core rod and 30 tons as stationary core rod. F. J. Stokes Machine Co., Philadelphia.

ELECTRIC IMPACT HAMMER. For high-speed staking, riveting, marking, wire cutting, blanking, forming or drawing of metals or other materials. Silicone-insulated coil in solenoid permits continuous operation at 150 blows per minute, delivering more than 1-ton impact. Requires less than 1 sq ft bench space. Black & Webster Inc., Needham, Mass.

PREFORMING PRESS. For preforming and molding plastics, powdered metals, generator brushes from carbon and copper mixtures, and ceramic products. Pressures of 55 tons possible in producing 50 preforms per minute. Primarily for round and odd shapes having 3-in. cell depth, 3½-in. diameter max. Brake stops press at any part of stroke. Adjustable for pressure, hardness, weight, thickness, and to compensate for variations in length of core rod. Arthur Colton Co., Detroit.

FLASH WELDER. Hydraulically operated platen and flash cycle control; air clamping. Replaceable insert dies minimize die cost. Includes water-cooled 50 kva transformer and clamps, welder type magnetic contactor. Agnew Electric Co., Milford, Mich.

POWER PRESS BRAKES. Range of sizes from 120 to 900 tons. For forming mild steel ⅛ to 1 in. thick from 4 to 20 ft long. Twin-drive main gears used in all but 120-ton model. Include motor-driven slide adjustment with micrometer controls, manually-operated multiple-disk clutch, and drum type friction brake. Wedge release mechanism relieves ram if brake is stalled by dies bottoming. Columbia Machinery and Engineering Corp., Hamilton, Ohio.

AUTOMATIC GAGING MACHINE. For air gaging and classifying refrigerating unit muffle boxes. Operator loads one fixture while machine is checking unit in other fixture. Permits checking 1500 parts per hr. Checks diameter and depth of counterbore and stamps proper classi-

More OEM's* Specify US Gauge Than Any Other Make!

* Original Equipment Manufacturers

...Because USG Assures More Value

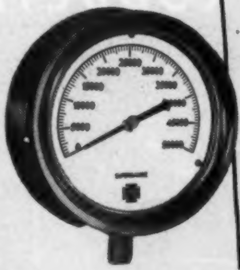
Throughout industry, the story is the same from year to year. Original equipment manufacturers (OEM's) demand substantial gauge value . . . accuracy, durability, and quality at economy prices . . . and 6 out of 10 specify US Gauges.

They know that US Instruments give more service, more accuracy, more *value* for the money. They know USG can supply all their needs—from highly specialized instruments measuring as low as 1" of mercury absolute, to standard type gauges measuring from 30" vacuum to 100,000 pounds pressure per square inch. And they know that for more than 40 years US Gauges have been the standard of dependability. So more original equipment manufacturers specify US Gauges than any other make.

Next time you order gauges, follow the lead of these satisfied users . . . buy US Gauges. For more information about US Gauge write today. United States Gauge, Division of American Machine and Metals, Inc., Sellersville, Penna.

SUPERGAUGE FIG. 1600

For heavy-duty service where a gauge of quality and high accuracy is required. Stainless steel movement with deep bushed bearings. Phosphor bronze, beryllium copper or welded stainless steel bourdon tube in iron or phenolic cases. Lower or back connections. Ranges: 0 to 30" vacuum, 15 to 20,000 lbs. p.s.i.



HIGH PRESSURE SOLID FRONT GAUGES

Designed for testing high pressure gases and liquids these gauges are built to the highest possible standard. Solid wall, cast integral with case, separates the tube and movement section from observer. Bourdon tubes of specially selected beryllium copper or stainless steel are threaded at both ends. Has deep bushed stainless steel movement of high ratio. Cast brass case and ring. Ranges: 100 to 100,000 lbs. pressure.

ABSOLUTE PRESSURE GAUGE

A highly accurate, dependable instrument for measuring absolute pressures. Gauge is seal case type designed to indicate pressure or vacuum admitted to interior actuating the seasoned beryllium copper diaphragm. Black molded phenolic case is corrosion resistant, suitable for use in highly contaminated atmospheres. Dial is 2¾" in diameter. Ranges: 20 millimeters to 100 inches of mercury.

US GAUGES—BETTER INSIDE...BETTER OUTSIDE...BETTER ON YOUR PRODUCT

USG

UNITED STATES GAUGE

PRODUCTS OF UNITED STATES GAUGE... Absolute Pressure Gauges • Aircraft Instruments • Air Volume Controls • Altitude Gauges • Boiler Gauges • Chemical Gauges • Dial Thermometers • Glass Tube Thermometers • Flow Meters • Inspectors' Test Gauges • Laboratory Standard Test Gauges • Marine, Ship and Air-Brake Gauges • Recorders • Controls and Alarm Gauges • Voltmeters • Ammeters • Welding Gauges

U.S. INSTRUMENTS Tell The Truth

USG

fication on part. Lights indicate which dimension is out of tolerance. Sheffield Corp., Dayton, Ohio.

HYDRAULIC PRESS. For hot pressing threaded and plain porcelain electrical insulators, and for general pressing and forming operations on plastic materials. Combines controlled tool rotation with preregulated pressing tonnage. Operated as manually controlled single-cycle unit or as continuous cycling unit. Hufford Machine Works Inc., Redondo Beach, Calif.

DIECASTING MACHINE. Modified to handle all standard zinc alloys as well as lead and tin-base alloys. Uses hydraulic suction to fill cylinder, permitting all metal in pot to be used before refilling. High speed, air operated with pilot and ram valves integral. Utilizes low-cost, single-cavity dies. Includes hand and foot controls. DCMT Sales Corp., New York.

ELECTRIC IMPACT WRENCH. Portable, 6-lb 14-oz tool has capacity of ⅝-in. cap screws or bolts, ½-in. studs. Free speed, forward or reverse, of 2150 rpm; strikes 2000 blows per min. Independent Pneumatic Tool Co., Aurora, Ill.

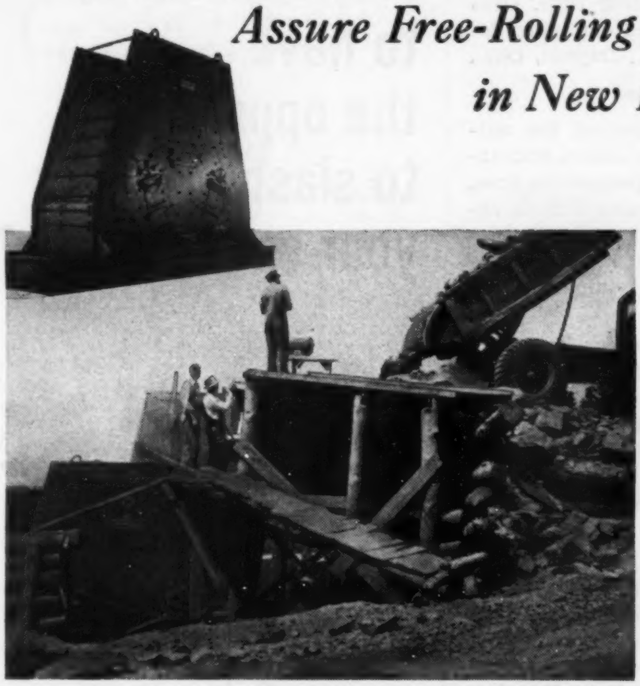
UTILITY GRINDER. Uses abrasive belts for grinding, polishing and deburring. Different quality grit belts can be used at same time. Machine consists of arbor head, idler unit, straight-faced contact roll, and abrasive belts. Convertible into buffing machine. Aluminum oxide belts in 4 grits available for general use on steel, brass, forgings, die castings, and some plastics. Delta Manufacturing Div., Rockwell Manufacturing Co., Milwaukee.

FLASH-BUTT WELDER. Designed for pipe and tubing. Welding heads swivel mounted permitting pieces to be butt or flash-butt welded at an angle. Automatic action controlled by microswitches. Foot valve and air cylinder with pressure regulator for each clamping jaw. Upset action has separate controls. Rex Welder and Engineering Co., Kansas City, Mo.

WIRE WELDER. Contains 12 welding pressure heads with die blocks. Welds one or more wires simultaneously; longitudinal wires of any spacing from 1/16-in. wire spaced on ¼-in. centers to 5/16-in. wire spaced from ½ to 12 in. on centers. Automatic feeding of cross wire and indexing of longitudinal wires. Sciaky Brothers Inc., Chicago.

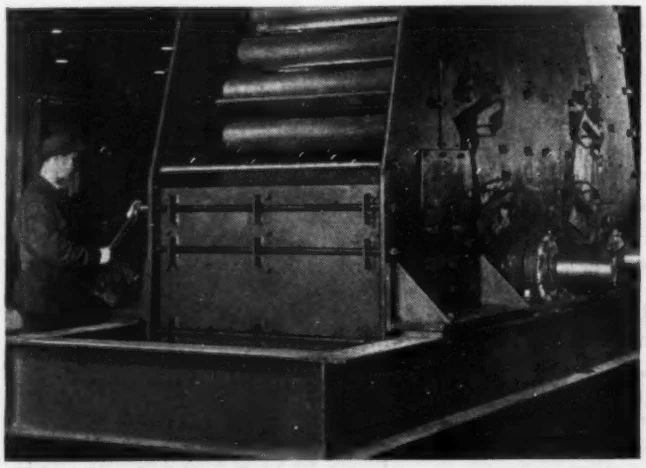
SPLINE BURRING MACHINE. For burring of involute or straight splines. Will burr spline where adjacent shaft diameter approaches root di-

Torrington Spherical Roller Bearings Assure Free-Rolling Alignment, Long Service Life in New Holland Double Impeller Breaker

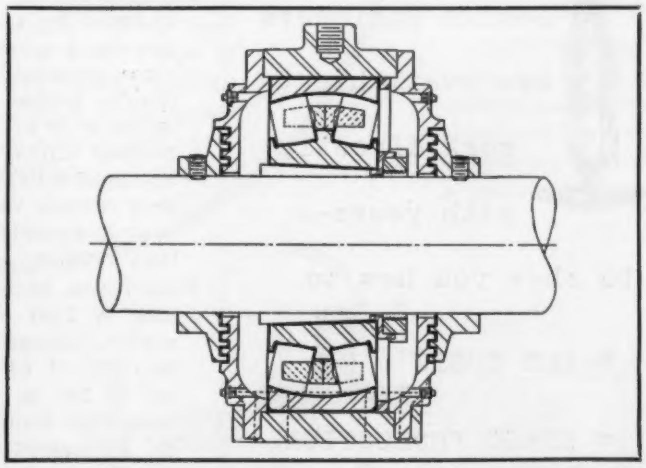


"Two immense rotating impellers are the business end of the Model 5050 Double Impeller Breaker," says Mr. Rollins of the New Holland Manufacturing Company. "Mounted for dependability on Torrington Spherical Roller Bearings, they crush 50-inch stones by a series of impacts applied in suspension."

Ease of assembly and accessibility is assured by the unit design of Spherical Roller Bearings and the simplicity of the pillow block mounting. The bearings carry the 13,400 pound dead weight of the impellers plus the heavy shock loads of operation with an ample margin of safety.

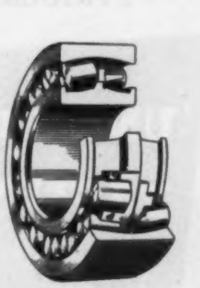


"One of the problems in the design of the Model 5050 Double Impeller Breaker," says Mr. Rollins, "was to secure proper alignment of the impellers on the massive welded frame. The self-aligning feature of Spherical Roller Bearings solved it for us, and there's no worry about shaft deflections in service."



Bearing clearances, vital for precise operation and long service life, can be accurately controlled by the adjustment of tapered sleeves, shown in the cross-section above. Axial stability of impeller shafts is provided by the two-direction thrust capacity of the Torrington Spherical Roller Bearings.

Heavy-duty equipment can be given a long lease on life with Torrington Spherical Roller Bearings. Torrington's engineers offer their specialized experience in every industry to help solve your friction problems. Call or write the nearest Torrington office. THE TORRINGTON COMPANY, South Bend 21, Ind., Torrington, Conn. District Offices and Distributors in Principal Cities.



TORRINGTON SPHERICAL ROLLER BEARINGS

Spherical Roller • Tapered Roller • Straight Roller Needle • Ball • Needle Rollers

ameter of spline. Average 10 tooth spline requires 3 seconds machine time, 7 seconds loading time. Uses hand or air operated clamping device. Sheffield Corp., Dayton, Ohio.

Materials Handling

FORK TRUCK. Gas powered for outdoor duty. Features 112-in. lift, 42-in. standard forks, pneumatic tires, condensing muffler, and 6000-lb capacity. Standard forks interchangeable with forks for handling concrete block. Clark Equipment Co., Battle Creek, Mich.

ELECTRIC HOIST. Capacities from 1000 to 20,000 lb. Incorporates all-steel construction, steel gear train, and swaged-on cable fittings. Furnished in lug, plain, or geared trolley, 4-part single reeve, base mounted, and with motor-driven trolley. American Chain & Cable Co. Inc., York, Pa.

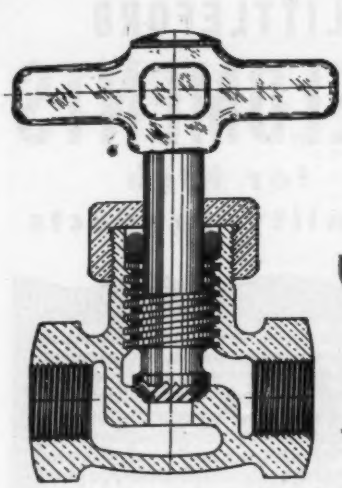
DIE TRANSFER TABLE. Overhanging, counterbalanced top permits transferring dies from press having extended base. Table hydraulically elevated from 28 to 44 in. Unit has 30 by 30-in. main top, 14 by 24-in. overhanging top, foot pump, floor lock brake, and 5-in. casters. Lyon-Raymond Corp., Greene, N. Y.

STRADDLE TRUCK. Capacity, 18,000 lb. Powered by 6-cyl., 82-hp engine. Includes 4 speeds forward and reverse, pneumatic tires, 4-wheel hydraulic brakes. Geared for max speeds of 30 to 45 mph as required. No-load turning radius of 12¼ ft. Equipped with mechanical swinging shoe control; vacuum or automatic controls available. Hyster Co., Portland, Oreg.

FORK TRUCK. Battery operated. Available in 1000 or 1500-lb capacity models. Collapsed height of 78 in., free lift of 68 in., and telescopic lift of 134 in. Smaller truck, designed for 30-in. load, weighs 2360 lb. Permanent 2½-degree tilt at centering point. 10-degree backward tilt; 5-degree forward tilt. Automatic Transportation Co., Chicago.

PALLET TRUCK. Powered by air-cooled engine, handles loads of 4000 lb up 15-degree ramp. Two 9-in. forks, 48 in. long, spaced 9 in. apart provide 4-in. lift. Truck negotiates aisles slightly wider than pallet being handled, turns in own length. Automatic transmission eliminates gear shifting. Salsbury Corp., Los Angeles.

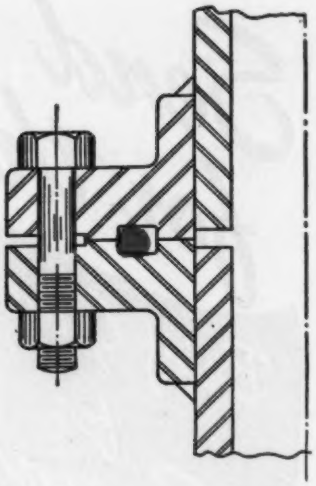
BATTERY OPERATED STACKER. Lifts to 130 in. Collapsed height, 83 in. Handles 2000 lb with 48-in. load, or 3000 lb with 28-in. load. Combines 3 speeds forward and reverse with automatic tilt of 10 degrees back



SHOWER VALVE

LINEAR "O" rings eliminated cap gasket and materially reduced packing wear and replacement.

"O"* RINGS ARE VERSATILE



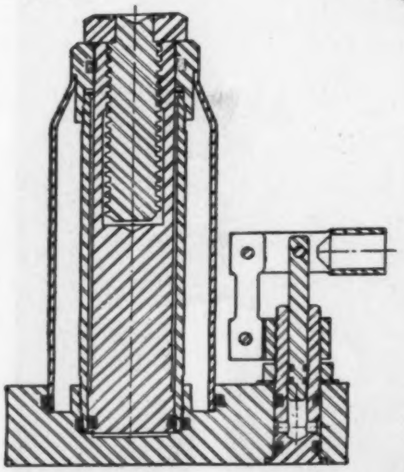
FLANGE UNION

With flange bolts stressed to resist separating force at maximum pressure, LINEAR "O" rings make positive liquid or gas-tight seals and are unaffected by vibration.

These are a few examples of the constantly increasing number of applications where LINEAR "O" rings are simplifying designs and cutting production costs. For highly specialized conditions, LINEAR is successfully moulding "O" rings of Kel-F, Teflon and Silicone. Available is a long list of natural or synthetic rubber compounds adaptable to a wide range of temperatures, gases and liquids. LINEAR engineering experience is at your disposal —send full details and copies of your blueprints.

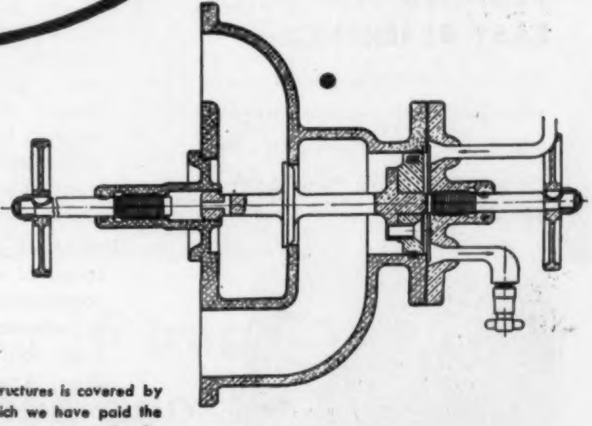
HYDRAULIC JACK

LINEAR "O" rings eliminated 14 parts and increased service life 100%.



RELIEF VALVE

LINEAR "O" rings enabled the manufacturer to eliminate 5 parts and effect savings of 22.4% in production costs.



* The use of "O" rings in certain packing structures is covered by Christensen Pat. No. 2,180,795 under which we have paid the royalty for the installation of our rings in these structures so that the royalty is included in the purchase price of the "O" ring.

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK STREET, PHILADELPHIA 35, PA.

and 5 degrees forward. Lift hydraulically operated. Automatic Transportation Co., Chicago.

ELECTRIC LIFT TRUCK. Handles 2000-lb loads, lifts 121½ in. Turns in 60-in. intersecting aisles or 109-in. right angle aisle. Full load speed, 5¼ mph. Dual-cylinder, low-pressure hydraulic lift mechanism; lifting speed, 28 fpm; lowering rate, 45 fpm. Elwell-Parker Electric Co., Cleveland.

TILTING HAND STACKER. Battery-operated hand truck in single lift or telescopic models. Provides 21 degree backward and 5 degree forward tilt. Both single lift, with 64-in. max lift, and telescopic model, with 120-in. max lift, will pass through standard 7-ft factory door. Designed with 4⅝ in. clearance beneath frame. Capacity, 3100 lb with 28-in. load or 2100 lb with 48-in. load. Hydraulic pressure for lift supplied by motor driven pump. Automatic Transportation Co., Chicago.

HAND LIFTER. For raising or lowering loads of 500 lb to 58 in. max height. Crank operates through planetary gear drive which permits holding platform at any level. Handle will not spin on lowering. Arc-welded tubular base members reinforced by tubular braces. Platform, 24 by 24 in., lowers to 5½ in. Lewis-Shepard Products Inc., Watertown, Mass.

Metalworking

METAL REMELTER. For soft metals. Capacity, 2000 or 650 lb. Standard models permit temperatures to 850 F. Automatic temperature control optional. Heated by electricity or any type gas. Complete with hinged cover, ventilating pipe connection, bottom draw-off valve with swing spout, and heating arrangement. Also available in larger models. Nolan Corp., Rome, N. Y.

HYDRAULIC SHAPER-PLANER. Combines speed of shaper with accuracy and convenience of planer. Hydraulically actuated feeds and table drive. Dual controls for rail head and table. Available with two heads with tool lifters for crossrail, two side heads with lifters. Three sizes: 24 by 24, 30 by 30, and 36 by 36 in. All models in 6, 8, 10, and 12-ft lengths. Rockford Machine Tool Co., Rockford, Ill.

PUMP BODY FINISHING MACHINE. Mills both ends, drills 2 mounting holes, drills and taps 4 holes on right end, drills and reams 2 bearing holes, roughs and semifinishes 2 gear pockets, and forms pressure relief cavity on oil pump bodies. Handles 63 pieces per hour. Ten-

FLASH-BUTT WELDED RINGS and BANDS *by* AMERICAN WELDING

Flash-butt welded rings and bands . . . both carbon and alloy . . . prove to be superior. Records show that there is a substantial

SAVING IN THE PRICE OF RINGS
SAVING IN THE COST OF TOOLING

when rings and bands are produced by the American Welding *"Controlled Technique"* process of flash-butt welding.

If you use rings, bands, or any other welded product, send your specifications, quantity, and prints for prompt quotation.

REPRESENTATIVE FLASH-BUTT WELD TEST RESULTS (as welded) FROM AMERICAN WELDING AND MANUFACTURING COMPANY'S RESEARCH FILES.

MATERIAL	TENSILE STRENGTH
Armco Ingot Iron	47,000 psi.
AISI-C-1025	71,000 psi.
Stainless, Type No. 410	76,000 psi.
Stainless, Type No. 347	91,000 psi.
AISI-8630	115,000 psi.
Inconel-X	124,000 psi.
N-155	135,000 psi.

***Send* for 16 page illustrated booklet**

THE AW AMERICAN WELDING AND MANUFACTURING COMPANY

130 DIETZ ROAD • WARREN, OHIO

station machine cuts 9 pieces at a time progressively. Hydraulic feed for drilling, reaming and milling, lead screw feed for tapping. Cross Co., Detroit.

LATHE. Features 13-in. swing, new spindle design with 1-in. max collet capacity, improved bed way wiping system, and 1-point oiling system for reverse lever bracket and twin gear bushings. Available in 4, 5, 6, or 7-ft bed lengths. South Bend Lathe Works, South Bend, Ind.

JIG BORING MACHINE. Swiss precision machine combines accuracy with high output capacity. Features centralized controls, microscope with three-point suspension independent of rotating part of spindle. Capacity, 14 by 8 in.; accuracy of slide location, 0.00015 in. Hauser Machine Tool Corp., Manhasset, N. Y.

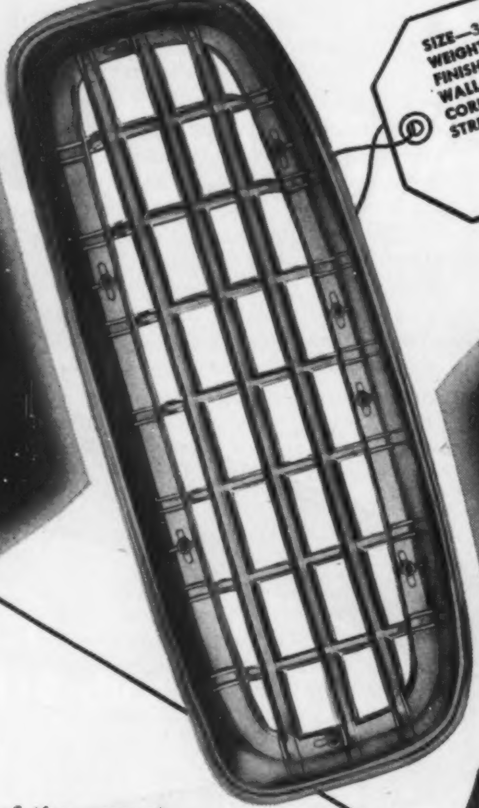
PIPE THREADING MACHINE. Automatic chucks grip and center pipe. Quick-opening die heads range from ½ to 2 in. Screw adjusts all segments simultaneously for changing depth of thread. Burring device on each head reams pipe as head is threading. Powered by ⅓-hp, 115-volt, ac or dc motor. Gears automatically select proper cutting speed. Quijada Tool Co. Inc., Los Angeles, Calif.

PRECISION LATHE. Collet capacity, 1 in.; bore through spindle, 1⅜ in. swing over bed 12¾ in.; and swing over carriage, 7⅝ in. Headstock and gear box enclosed and running in oil. Forged and hardened spindle ground while rotating on its own roller bearings. Enclosed motor drive gives infinite selection of spindle speeds. Clausing Manufacturing Co., Ottumwa, Iowa.

SHEET AND PLATE CUTTER. For beading, folding, or straight, circular or design cutting of metal to ⅜-in. thick. Cutting accomplished by 2 cutting tools, upper tool reciprocating at high speed. Cut performed by shearing action. Tools also available for slot cutting and nibbling. Pullmax Co., Chicago.

WAY GRINDING MACHINE. For grinding ways of large lathes. Grinder has 46-ft bed length. Table and wheel head feeds hydraulically operated by two lever control. Table speed from 10 to 100 fmp. Automatic wheelhead feed accurate to 0.0001 in. Hydraulic rapid traverse, 240 in. per min; hydraulic wheel truing, 6 in. per min. Wheelhead unit powered by 30-hp direct-mounted motor. Grinder, model CX 30 by 48 by 196 in., includes pressure pump interlocked with spindle motor for automatic lubrication. Thompson Grinder Co., Springfield, Ohio.

massive appearance-through *clever coring*



another successful product designed for ZINC DIE CASTING

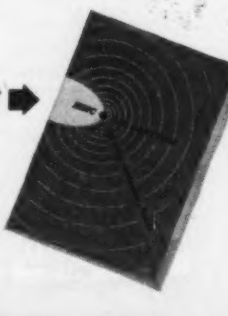
The radiator grilles of many of the current cars are built-up assemblies of die cast parts, but this particular design—for the 1949 Nash Airflyte— is a one-piece zinc die casting. Not only does a die casting meet the physical and mechanical requirements of this design (see tag on casting), but it consumes a minimum amount of metal.

The grille casting is shown from the rear to reveal the clever coring of the horizontal and vertical ribs. The ribs thus appear to be solid sections when viewed from the front, but the coring effects a considerable saving in both metal and weight—with no sacrifice of strength! This grille is tailored to fit the car instead of vice-versa and its inherent dimensional accuracy greatly reduces assembly problems. Note, also, the cast assembly bosses.

This is just one of many successful applications for zinc die castings in the automotive industry. Typical applications in other fields of manufacture will be covered in future advertisements in these pages.

SEND FOR THIS BOOKLET

A new booklet—just off the press—has 64 pages of photographs depicting zinc die castings in the assembly of a wide variety of products in many fields. Send for your copy today!



ZINC
FOR DIE CASTING ALLOYS

THE NEW JERSEY ZINC COMPANY, 160 Front St., New York 7, N. Y.

The Research was done, the Alloys were developed, and most Die Castings are based on

HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZINC

Change is FASTEST, EASIEST with Federal Noark Motor Starter

IT'S ALMOST "PRESTO, CHANGE!" replacing a coil in Federal Noark Motor Starters. Only three quick operations to get the old coil—three more, in reverse, to insert the new one. Federal design is the simplest, fastest on the market today. All parts readily accessible from the front. Saves time, effort and money.

What's more, there's almost no chance for trouble in Federal Noark Motor Starters. There's only one moving unit and that *rides on ball bearings*—an exclusive Federal feature!... Important, too, Federal permits the choice of getting automatic or manual reset instantly... simply turn a knob and you've the type of overload protection that you want.

Order Federal Noark Motor Starters from your Federal Distributor. And write us for free copies of the "Federalog" and "Simplified Motor Control" giving full descriptions. Federal Electric Products Company, 50 Paris St., Newark 5, New Jersey.

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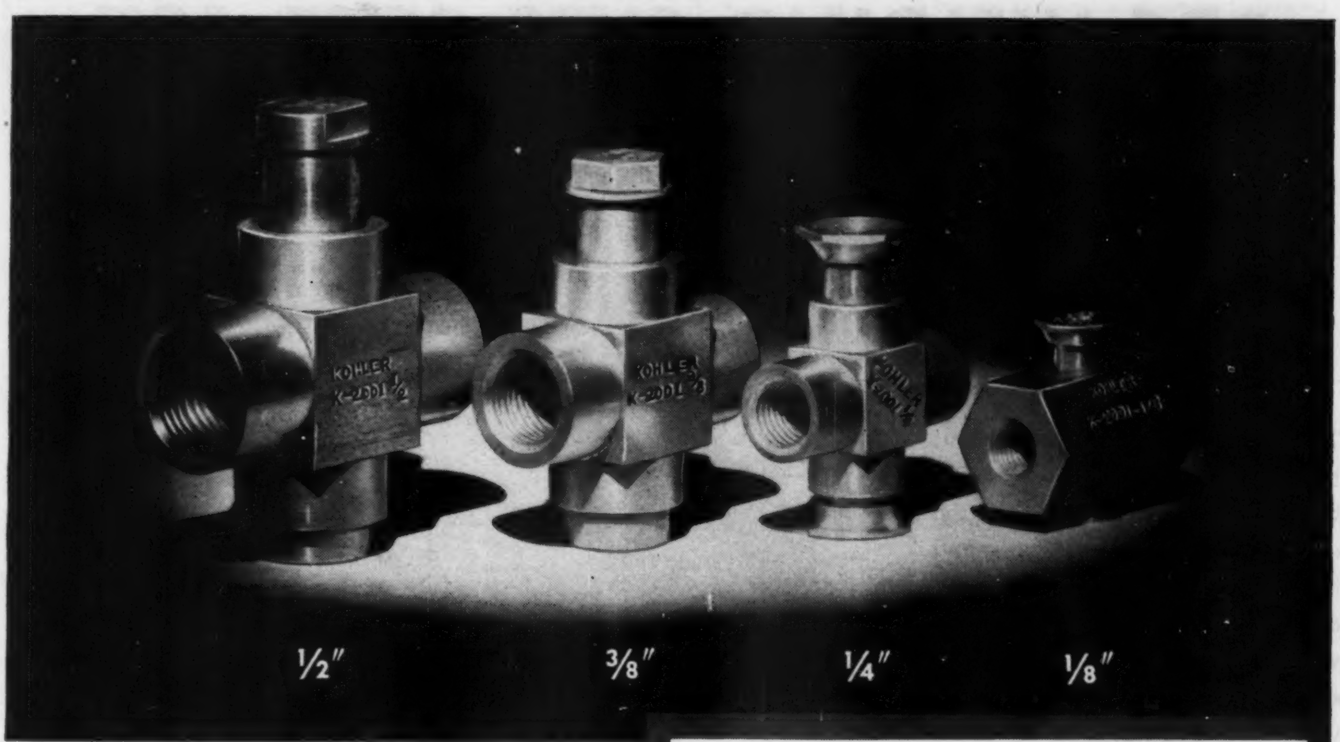
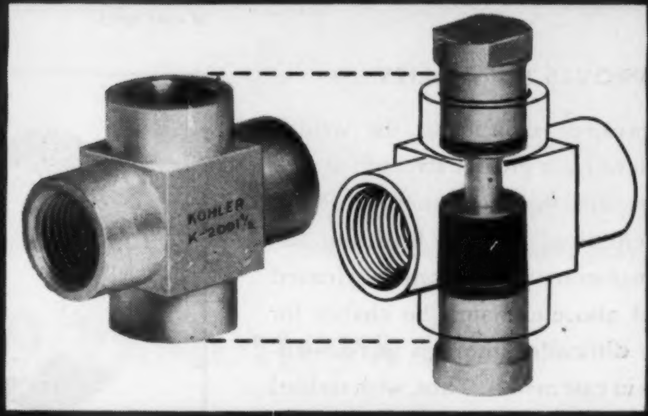
Complete line of Federal Electric Products includes Motor Controls, Safety Switches, Service Equipment, Circuit Breakers, Panelboards, Switchboards, Bus Duct ★ Sales offices in principal cities.



KOHLER K-2001½
KOHLER K-2001⅜
½"
⅜"
¼"
⅛"



KOHLER K-2001½

ARC WELDING CUTS COST 43%
...builds a stronger product

By A. D. NEAL,
Works Manager
B. F. Avery & Co.
Louisville, Kentucky

To avoid structural failures caused by striking hidden stumps or stones has been a major problem in the development of farm tractors and implements. By converting to welded design on key parts like axles and wheels, manufacturing has been simplified and field breakdowns virutally eliminated.

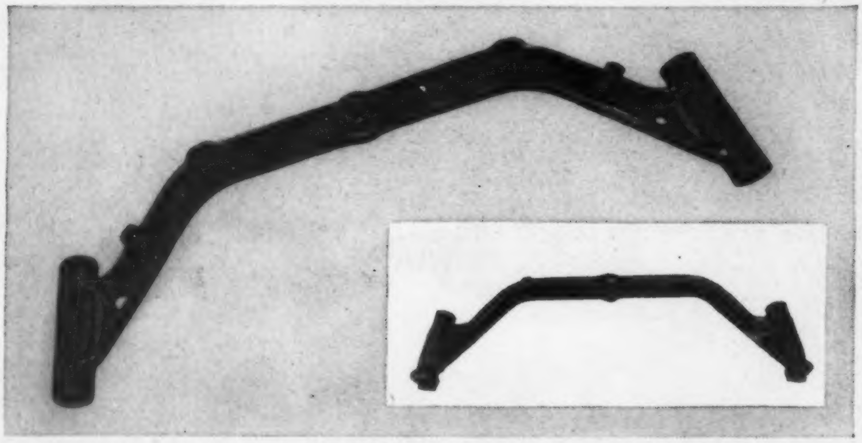


Fig. 1. *Weight reduced 30% . . . cost cut 43%.* Present design, all welded steel front axle. Has pressed steel channel frame and steel spindle housings. Inset shows former construction of cast steel.

IMPROVES DURABILITY

Experience shows that the welded designs have greater strength as well as exceptional resilience to severe mechanical shocks. Building the component parts from fabricated steel also eliminates the chance for any difficulties through inconsistencies in cast metals. Thus, with welded design, greater product dependability is achieved to meet unknown and abnormal operational needs.

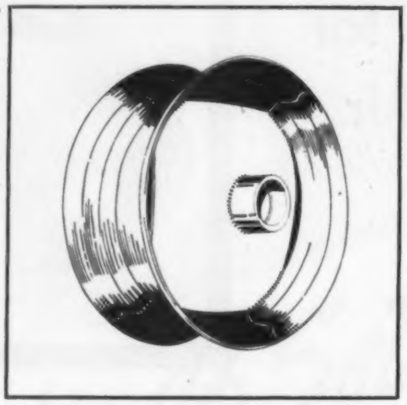


Fig. 2. *Stronger and more durable* all welded steel front wheel for farm tractor now used.

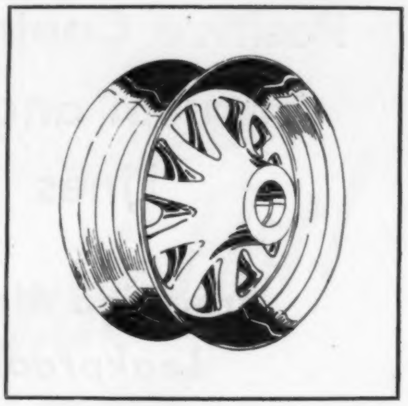


Fig. 3. *Former construction* had cast steel hub welded to rolled steel rim

SIMPLIFIES MANUFACTURE

Substantial savings in manufacturing costs result in fabricating our tractor and implement parts with arc welding. Less material is required since components are stamped from steel plate or machined from bar stock with high speed equipment. Arc welding is done on simple, quick operating swing-type fixtures permitting fast downhand welding. On most jobs, no further machining is required after welding.

Fig. 4. *Cost cut 62% . . . weight down 69%.* Weld-fabricating a front tractor wheel. Component parts shown on table are located in simple fixture for welding.

The above is published by **THE LINCOLN ELECTRIC COMPANY** *in the interests of progress.*

Machine Design Studies available to engineers and designers. Write The Lincoln Electric Company, Dept. 12, Cleveland 1, Ohio.

There Go 3269 Fasteners!

Tonight's test is tough . . . Doc Smith must get through . . . he's depending on the miracle of American mass production and (unknowingly) on the 3269 fasteners that give his car strength and stamina.

Over 500 screws . . . 331 nuts . . . 400 bolts . . . hundreds of rivets . . . furnish the forces that lock automobile assemblies together.

With this responsibility that fasteners must carry, it is obvious that quality is essential. That's why Russell, Burdsall & Ward makes the huge investment it does—in wire drawing mills of its own, in wire preparation, in laboratory equipment for extensive research, in advanced designs of equipment—all of which contribute to quality control.

Fastener *quality* and production savings go hand in hand. It isn't the initial price but the cost of *using* fasteners that counts. *True Fastener Economy* lies in *saving* assembly time, *reducing* the need for plant inspection, *getting* maximum holding power per dollar of fastener cost.

True Fastener Economy contributes to the kind of production savings that puts millions of new cars in U. S. driveways every year. It is this type of contribution to major American industries that explains why—for over 104 years—RB&W has been *making strong the things that make America strong.*

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

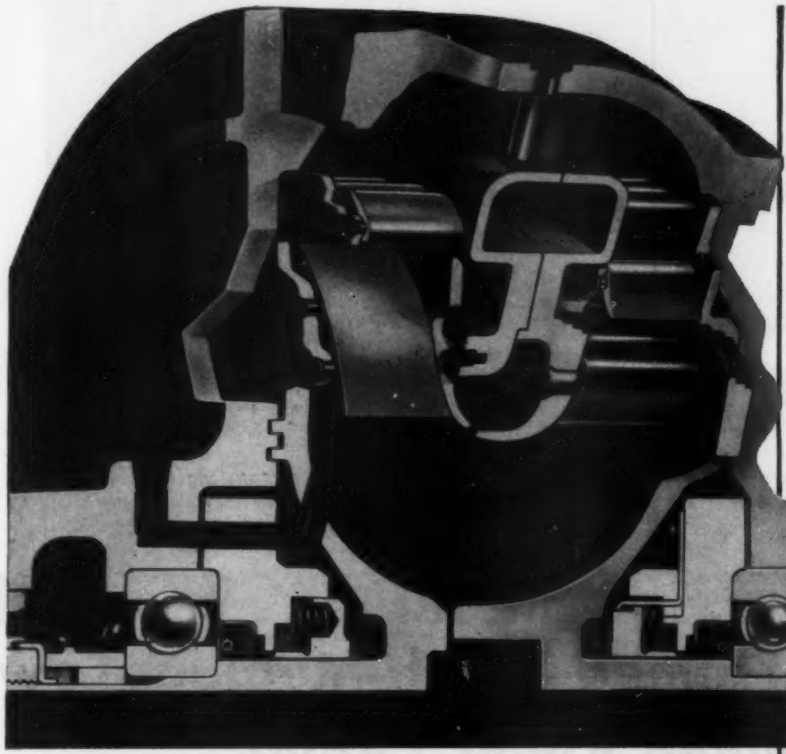
RB&W

Plants at: Port Chester, N.Y., Coraopolis, Pa., Rock Falls, Ill., Los Angeles, Calif. Additional sales offices at: Philadelphia, Detroit, Chicago, Chattanooga, Oakland, Portland, Seattle. Distributors from coast to coast.

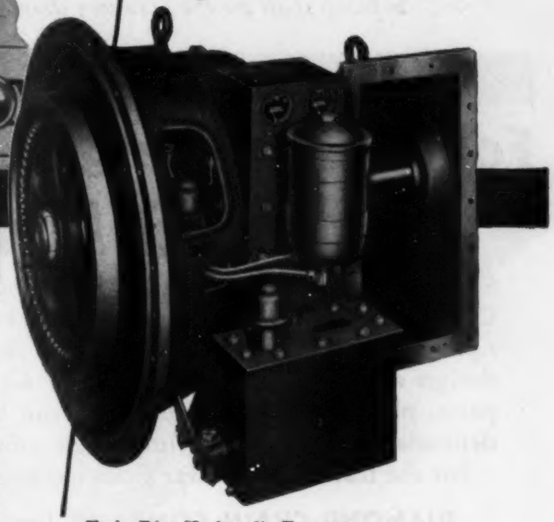
3269 Fasteners are used in 1 small American car

104 YEARS MAKING STRONG THE THINGS THAT MAKE AMERICA STRONG

Greatest • Overall TORQUE Multiplication



Sectioned view of Twin Disc Hydraulic Torque Converter



Twin Disc Hydraulic Torque Converter (Lysholm-Smith Type)

When considering power transmission units for equipment with high torque demands, designers turn naturally to Twin Disc's Lysholm-Smith Hydraulic Torque Converter, because it offers the greatest overall torque multiplication of any unit made today.

The hydraulic circuit of Twin Disc's Converter consists of a centrifugal pump discharging through a *three-stage* turbine, with two reaction stages interposed between the turbine stages. Maximum torque is developed at output shaft stall and is approximately five times engine torque . . . maximum efficiency is attained at an output speed ratio of approximately .5.

To apply a Twin Disc Torque Converter to any engine and machine assembly, it is necessary to select a converter with a proper pump size to absorb engine hp over its complete operating range. The drive ratios in the machine must be properly selected to obtain maximum converter performance throughout the complete range of output shaft operating speed.

The Twin Disc Hydraulic Division offers assistance in solving your power transmission problems. Torque Converter models are currently available with horsepower ratings from 50 to 600 hp. TWIN DISC CLUTCH COMPANY, Racine, Wisconsin (Hydraulic Division, Rockford, Illinois).

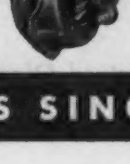
Power Take-off

Heavy Duty Clutch

Machine Tool Clutch

TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES
REG. U. S. PAT. OFF.

Tractor Clutch



Marine Gear

SPECIALISTS IN INDUSTRIAL CLUTCHES SINCE 1918

Steel-Weld FABRICATION

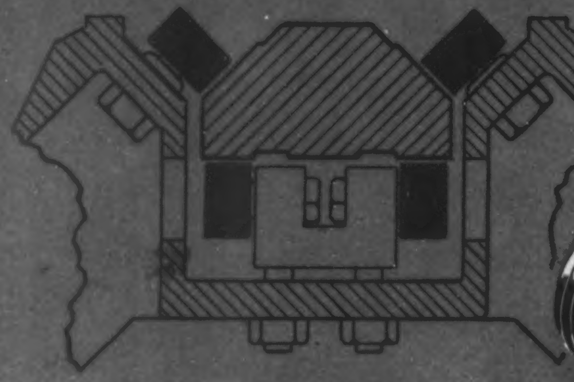
In Steel-Weld Fabrication, where craftsmanship of the individual workman is immediately apparent in the finished product, the Mahon Company excels. Complimentary letters from pleased customers are not uncommon in the Mahon organization—and they are considered rich compensation, because in this current era, word of a job well done travels fast and far . . . it is responsible for many new customers. The Mahon Company offers you a unique source for welded steel in any form, regardless of shape, size or weight . . . a source with complete heavy machining facilities and a staff of thoroughly competent design engineers. This combination assures you a better, smoother appearing job, embodying every advantage of Steel-Weld Fabrication.

THE R. C. MAHON COMPANY
Detroit 11, Michigan

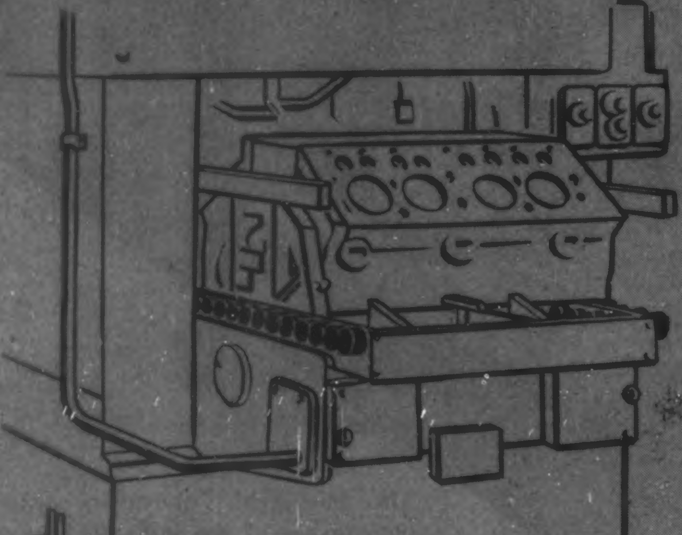
Engineers and Fabricators of Welded Steel Machine Bases and Frames, and Many Other Welded Steel Products

MAHON

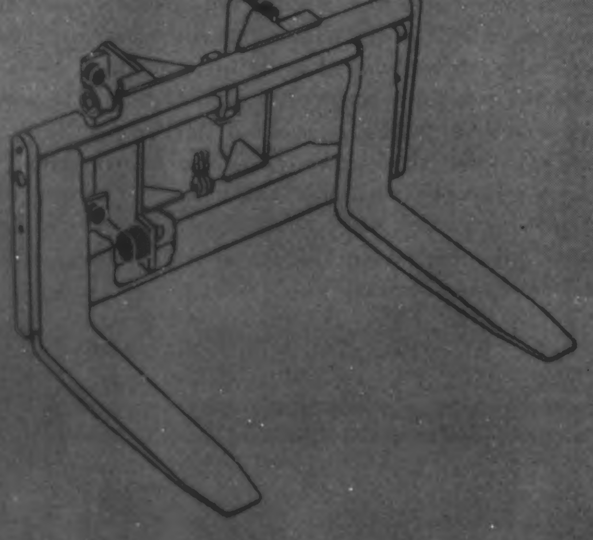
Increase Machine Efficiency *with . . .*



MULTIROL CF Series Bearings as support rollers for oscillating heads and tables on machine tools. Saves costly grinding and scraping of ways.



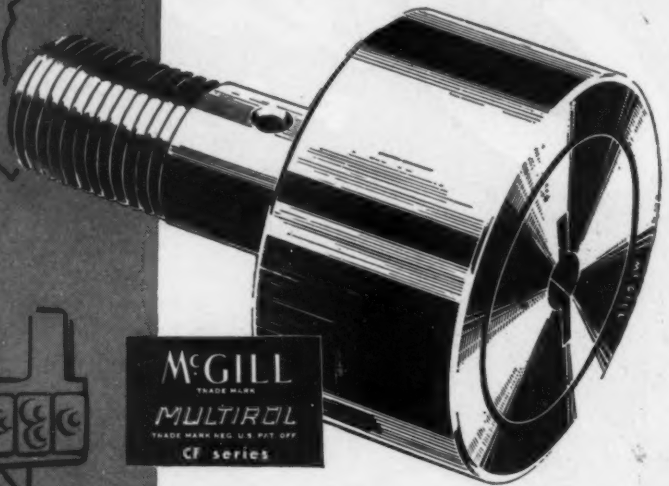
MULTIROL CF Series Bearings used as conveyor rolls on transfer machines. Precision construction of CF bearings permit accurate machining of parts passing across rolls.



MULTIROL CF Series Bearings as mast and platform guide rollers on lift trucks. Eases lifting and side adjustment of heavier loaded platforms.

ANTI-FRICTION PERFORMANCE

the MULTIROL way



McGILL
TRADE MARK
MULTIROL
TRADE MARK REG. U.S. PAT. OFF.
CF series

When your design goal is the ulumate in anti-friction performance . . . when your specifications include heavier static and shock load capacity . . . then MULTIROL Cam Follower (CF series) bearings are what you've been looking for.

The Cam Follower is a rugged bearing. An extra heavy outer race section stands the repeated shock of cam operation. A full complement of small diameter rollers make up an almost unbroken steel ring which distributes the load evenly over a greater bearing surface. Internal wear and friction are held to the minimum, and power requirements of MULTIROL bearing equipped machines are appreciably lessened. CF bearings are easily lubricated through the stud or face of the bearing and sufficient lubrication is retained for adequate protection of those neglected applications.

MULTIROL Cam Follower bearings are precision built in a range of twenty-two standard roller diameters from ⅝" to 4". This wide variety eliminates the need for special cam follower specifications in most machine design.

For dependable and long lasting anti-friction applications, at lower cost, investigate MULTIROL CF series bearings. Ask our engineers for their recommendations.

Write for Bulletin CF-40A. McGILL Manufacturing Company, Inc., 200 North Lafayette Street, Valparaiso, Indiana.

McGILL
TRADE MARK
precision bearings

108 A's ON HIS REPORT CARD

HE HAS TO PASS WITH HONORS BEFORE HE CAN GO TO WORK FOR YOU

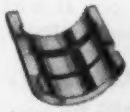
THE flanged copper-lead sleeve bearing shown above was graduated from a rigid "school" conducted by Federal-Mogul's Quality Control group.

In the process of 28 manufacturing operations, this bearing received a series of precise setup and inspection measurement checks—84 in all! Twenty-four additional tests included analyses, temperature controls, special and visual examinations.

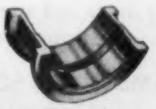
Where "A" meant 100%, this bearing passed 108 times! Otherwise, it never would have left the factory.

The same vigilant care is exercised throughout all six Federal-Mogul plants, in the manufacture of *every* bearing. We are equipped for large or small runs, to your specifications. Consult our engineers on *your* bearing requirements.

HIGH SPEED, high temperature, automotive type bearings available in many combinations.



HEAVY LOAD for big Diesels, power plants, etc.—bearings up to 27½" O.D., steel and bronze back.



SPEED & LOAD bearings for pumps, compressors, industrial electric motors and similar uses.

BRONZE PARTS in many shapes, sizes; thrust washers, bushings; for many types of applications.

Power goes to work smoothly through

FEDERAL-MOGUL

FEDERAL-MOGUL CORPORATION FEDERAL Mogul *Silent* SLEEVE BEARINGS **11045 SHOEMAKER, DETROIT 13, MICH.**

OUTDOOR FURNITURE MAKERS
Can Relax and Rest Easy

...when their costs are fastened down ... and sales speeded up ... by AMERICAN PHILLIPS SCREWS

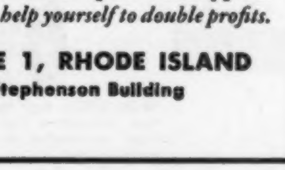
VACATION FROM COST-WORRY: Assembly costs are controlled . . . *fixed and held as much as 50% lower than you ever saw them before* . . . when old-fashioned slotted screws are replaced by modern, power-driven American Phillips Screws, the *only* screws with the crossed, *cornerless* recess. Production and product-quality go up as worker-fatigue goes down. And profits flourish as rejects and spoilage all but vanish.

VACATION FROM SALES-WORRY: Customers *don't* like bungled fastenings with ugly, marred surfaces and broken screw-heads that snag clothes. And that's exactly why they *do* like American Phillips-fastened products . . . because every fastening is cleanly made and attractive to look at, with never a burred head to spoil sales-appeal. So fasten *your* product with American Phillips Screws . . . *and help yourself to double profits.*

4-WINGED DRIVER CAN'T SLIP OUT OF PHILLIPS TAPERED RECESS

AMERICAN SCREW COMPANY, PROVIDENCE 1, RHODE ISLAND
Chicago 11: 589 E. Illinois St. *Detroit 2: 502 Stephenson Building*

AMERICAN PHILLIPS *Screws*

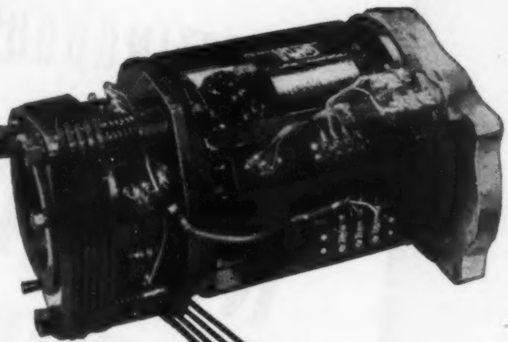


ALL TYPES
ALL METALS: Steel, Brass, Bronze, Stainless Steel, Aluminum, Monel, Everdur (silicon bronze)


YOU CAN'T BEAT A
TRI CLAD MOTOR FOR
EASY MAINTENANCE
GENERAL ELECTRIC
HERE'S
WHY

FIBERGLAS*

...helps provide dependable finger-tip control



Moving tons of earth in a hurry is an easy job with LeTourneau Tournapulls. Easy—because they're operated by finger-tip control. Just a flick of a switch is all that is required to start electric motors that load, steer, turn and empty these giant earth movers. And *dependable* motors are highly important in this automatic operation because these machines work under the toughest weather conditions. That's why LeTourneau provides added protection by using motors insulated with Fiberglas-base Electrical Insulating Materials.

Other leading designers and engineers have found it's good insurance to have the added protection of Fiberglas-base Insulations. They've found, too, that these inorganic-base materials have helped solve problems such as the need for reduction in motor size, resistance to the effects of heat, overload, moisture, most corrosive acids and vapors, dust and many other causes of motor insulation failures. If you have a motor insulation problem, get more information about the advantages of these dependable materials by writing to Owens-Corning Fiberglas Corporation, Department 808, Toledo 1, Ohio, today for your copy of the "Fiberglas Electrical Insulating Materials" manual. Branches in principal cities.

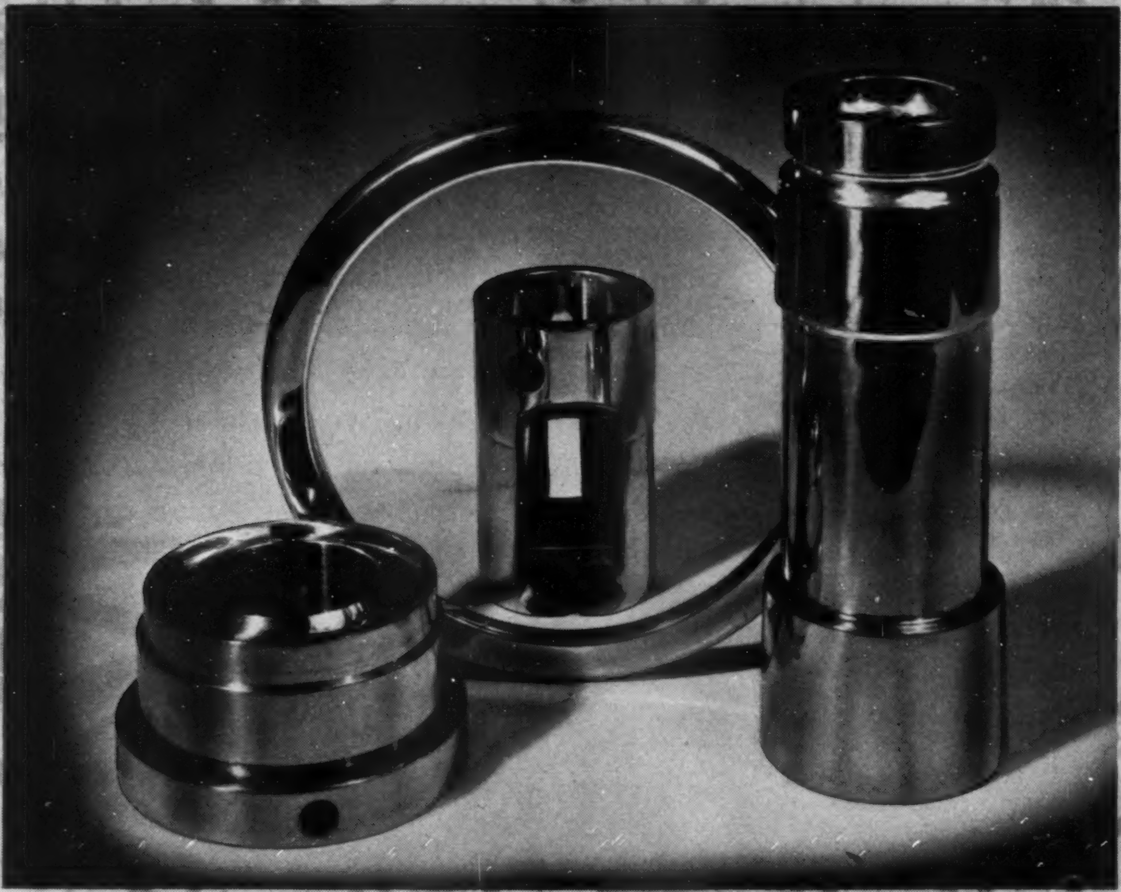
In Canada: Fiberglas Canada Ltd., Toronto, Ontario.

LeTourneau Tournapulls, equipped with Fiberglas-insulated motors, generators and transformers, are manufactured by R. G. LeTourneau Inc., Peoria, Illinois.

OWENS-CORNING

FIBERGLAS

ELECTRICAL INSULATING MATERIALS



If precision is your problem, sleeve bearings will solve it to the fullest extent . . . In modern aircraft engines and their superchargers—on the spindles of precision machine tools—where precision is paramount—Bunting Cast Bronze sleeve bearings are used . . . Versatile in design and alloy, Bunting Bearings offer advantages which we would like to discuss with you. The Bunting Brass & Bronze Co., Toledo 9, Ohio. Branches in Principal Cities.

Bunting

BRONZE BEARINGS ☆ BUSHINGS ☆ PRECISION BRONZE BARS

42


ATLAS
U.S.A.

for METALLIC GASKETS

add this NEW NAME to your source list!

The New Source with New Resource

FEL-PRO...a brand new name you can rely on to give you Metallic Gasket service with a fresh viewpoint... a new slant on delivery action and productive ideas... the latest in complete, modern facilities.

FEL-PRO facilities are geared 100% to the design, development and manufacture of Metallic Gaskets, as well as all types of gaskets, steel and felt retaining rings, copper washers, metallic gaskets combined with asbestos, felt, rubber or synthetics and any others which your requirements may call for. These facilities have been built up step-by-step over a period of 30 years. They have grown at a sensible, deliberate pace, marked by constant improvements and developments in the field of Metallic Gasket manufacture.

Right now, our plant, our machines, our creative man power—our entire facilities—are in their prime. All of them stand directly behind the unique FEL-PRO Resource of discovering, developing and combining conventional and synthetic gasket materials to the profit of our customers.

Get a Metallic Gasket Quote from FEL-PRO

We welcome the opportunity to prove to you that FEL-PRO really is the NEW SOURCE with NEW RESOURCE. Send us copies of your specifications on needed Metallic Gaskets (or other types), we'll return a quotation to you which is sure to prove our point! Of course there is no cost or obligation to you . . . it's FEL-PRO's way of introducing you to the complete FEL-PRO Facilities which can serve you better—*YOUR NEW SOURCE with NEW RESOURCE.* Write . . . **FELT PRODUCTS MFG. CO., 1517 Carroll Avenue, Chicago 7, Illinois.**

also send for FREE SHEAF of SAMPLES

of our workmanship in Metallic Gaskets and other types. Just write us to send you a copy of Sample Folder M 41-B.

FEL-PRO

Metallic
ORIGINAL EQUIPMENT GASKETS

3014

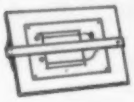
TWO ways you benefit from MB Isomode* Vibration-Isolators

1. IMPROVED VIBRATION CONTROL!

2. EASIER ENGINEERING!

Experiences of two well-known manufacturers demonstrate this double benefit:

Always on the alert to improve their product, a truck maker comprehensively tested Isomode mounts. Their adoption followed quickly. Because, instead of previous, typical truck characteristics, motors mounted on *Isomode* units displayed passenger-car performance! *Vibration was really isolated*, even though the units were not at optimum locations, but placed at standard points to allow interchangeability with earlier models.



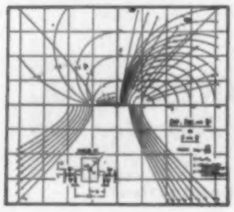
Another company, with a tough vibration control problem because they use various makes and types of engines in their own product, discovered *engineering and production simplicity* through Isomode units. Vibration was controlled by units placed at the regular mounting points. This accomplishment is all the more remarkable when you consider that the vibration varies with each type of engine!

There you have actual demonstrations of the value of Isomode units' outstanding advantage—"equal spring rates in all directions". The same benefits apply to *many* products—engines to electronic assemblies. And you not only isolate them more easily, but also gain a mounting that *withstands severe shocks!*

**Trade Mark Reg. U.S. Pat. Off.*

THE ADVANTAGES OF designing with ISOMODE MOUNTS

- ✓ *They absorb vibration in all directions* equally well—vertical, as well as troublesome horizontal and rocking motions.
- ✓ *Non-directional*—can be mounted at any angle, in any direction, simplifying design problems.
- ✓ *High load capacity* in compact size—saving space, weight, costs.
- ✓ *Large rubber volume* for softness—yet perfectly stable and self snubbing.



SEND FOR YOUR FREE COPY

This Isomode design chart saves you hours and effort—locates best points on your product at which to place standard mountings. For bulletin which contains chart and helpful information on vibration control, write Dept. F3.

THE MB MANUFACTURING COMPANY, INC.
1060 State Street
New Haven 11, Conn.
VIBRATION ISOLATOR UNITS • VIBRATION TEST EQUIPMENT

VIBRATION DIVISION

Typical Example of WELLMAN Leadership in Light Metal Casting

Domestic Appliances

● The plants of this company have produced a tremendous tonnage of light metal castings for the domestic appliance field . . . typical examples being vacuum cleaner parts, ironer housings and washing machine parts. For over 36 years this industry has called on our facilities to cast a great variety of such parts. We are equipped to handle any of your requirements for magnesium aluminum, or bronze castings . . . whether it's domestic appliances, aircraft parts, pneumatic tools, machinery, automotive, or any of the other applications where light metal castings are used.

Your job will be under complete laboratory control from raw metal to finished casting; X-Ray inspection assures quality; and our years of experience will work to your advantage.

Just send us your blue prints — or ask us to send our representative.

Remember Wellman means Well-Cast.

THE WELLMAN BRONZE & ALUMINUM COMPANY

GENERAL OFFICES:

2547 EAST 93rd STREET • CLEVELAND 3, OHIO

CASTINGS *X-RAY INSPECTED*

For Superior Performance . . .

DESIGN

with ACADIA *Synthetic Rubber*

SHEETS • EXTRUSIONS
CUT AND MOLDED PARTS

Component parts processed from Acadia Synthetics excel in many characteristics—including plasticity, elasticity, resilience, etc.—plus greater resistance to light, air, heat, wear, oil and age. Possible applications are almost unlimited. Acadia Synthetic Rubbers cut, mold and extrude to very close tolerances—in any shape, size or type.

In checking specifications, you may find that the original part, re-designed in an Acadia Synthetic, gives superior performance, greater dependability and longer service—*very often at lower cost.* Whatever your requirements may be . . . Acadia's engineers will gladly help you select the right synthetic rubber and adapt it to your product. *Write today.*

DIVISION OF WESTERN FELT WORKS

ACADIA *Synthetic* **PRODUCTS**

Processors of Synthetic Rubber and Plastics • Sheets • Extrusions Molded Parts

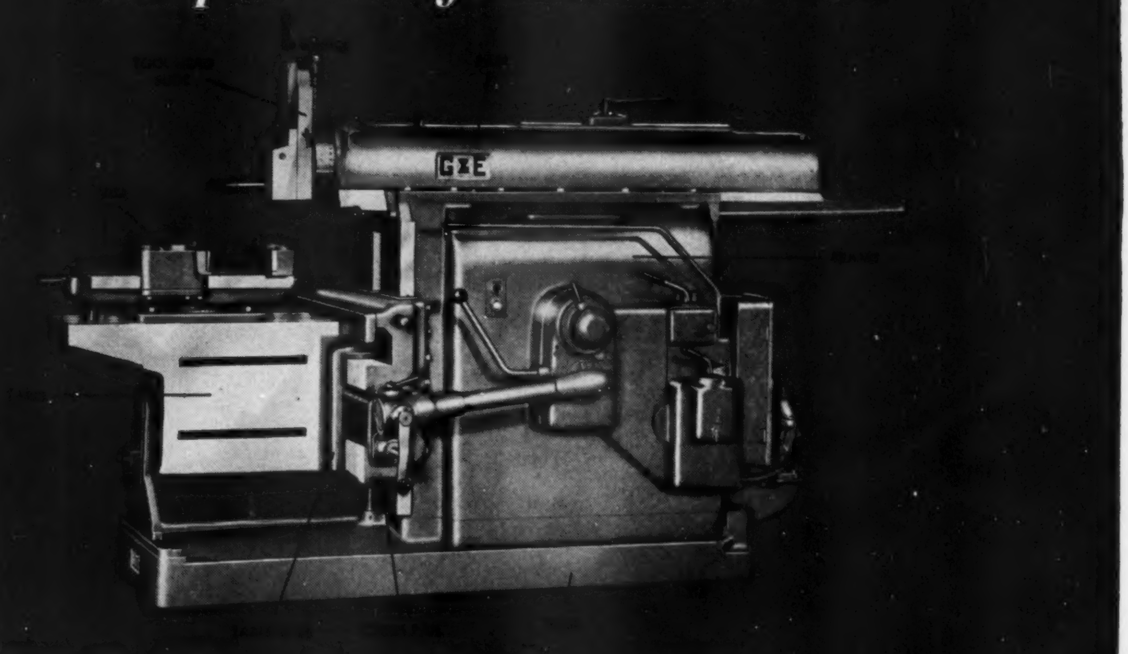
DIVISION WESTERN FELT WORKS

Branch Offices in All Principal Cities

Largest Independent Manufacturers and Cutters of Felt

4035-4117 Ogden Avenue, Chicago 23, Illinois

For OUTSTANDING Shaper Performance . . .



Gould & Eberhardt Specify MEEHANITE® Castings

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American Brake Shoe Co.	Mahwah, New Jersey
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, New Jersey
H. W. Butterworth & Sons Co.	Bethayres, Pennsylvania
Continental Gin Co.	Birmingham, Alabama
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio and Grove City, Pa.
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General Foundry & Manufacturing Co.	Flint, Michigan
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Pohlman Foundry Co., Inc.	Buffalo, New York
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
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Shenango-Penn Mold Co.	Dover, Ohio
Sonith Industries, Inc.	Indianapolis, Indiana
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Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
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Valley Iron Works, Inc.	St. Paul, Minnesota
Vulcan Foundry Co.	Oakland, California
Warren Foundry & Pipe Corporation	Phillipsburg, New Jersey
E. Long Ltd.	Orillia, Ontario
Otis-Fensom Elevator Co., Ltd.	Hamilton, Ontario

"This advertisement sponsored by foundries listed above."

HAVING developed and manufactured Shapers for more than ninety-five years, Gould & Eberhardt, Incorporated, Irvington, New Jersey, recognize the importance of selecting the right component material in translating superior engineering design into superior performance.

The production sequence from idea-to blue-print-to manufacturing procedure-to final better service in customers' plants is of special importance not only to the manufacturers of machinery and machine tools but to the users of them.

The function of castings in this sequence is particularly a vital one today and the type, quality, and engineering characteristics provided by better castings can mean the difference between outstanding leadership and quality in the field or a mediocre product.

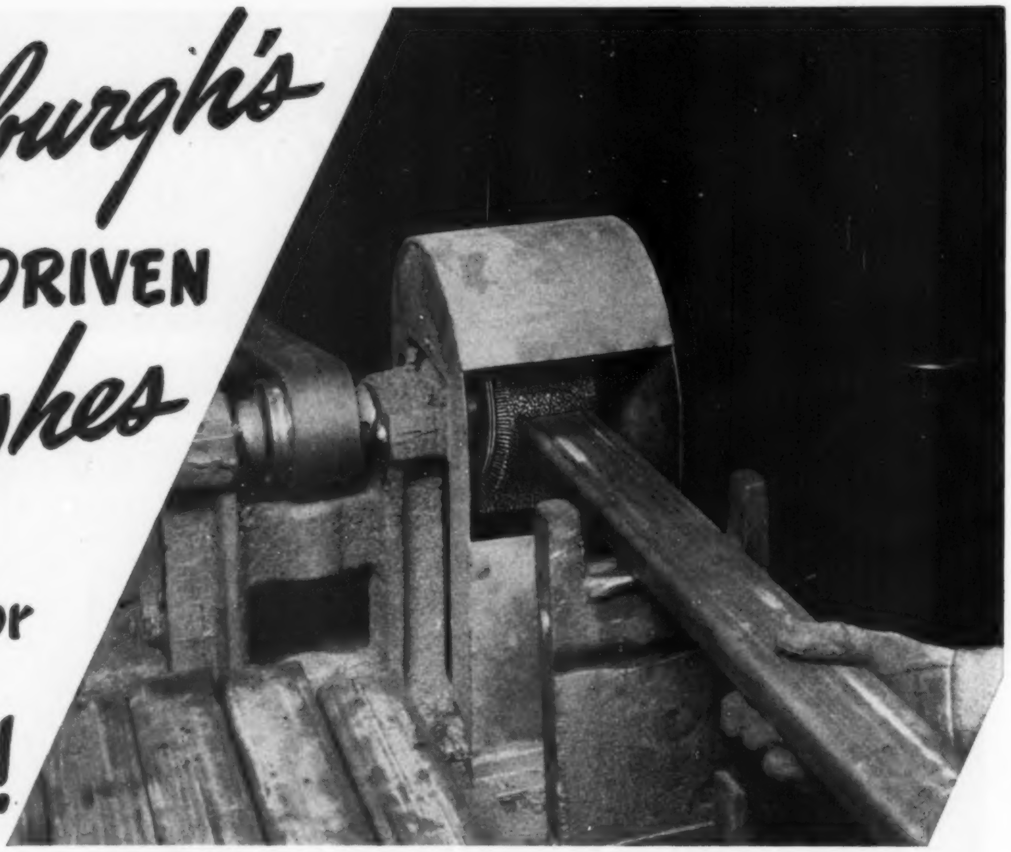
Meehanite castings are used for the eight major parts of the Gould & Eberhardt 32" Industrial Shaper illustrated. The internal crank mechanism comprising main lever, crank plate, and bull gear, also are Meehanite castings. The eleven Meehanite castings used in this shaper contribute the superior engineering characteristics necessary to provide in proper combination better wear, high strength, toughness, dimensional stability, rigidity, machinability, and finish.

For the complete details of the engineering properties and industrial applications of Meehanite castings, write for the Meehanite Handbook.

MEEHANITE®

PERSHING SQUARE BUILDING • NEW ROCHELLE, N. Y.

Pittsburgh's POWER DRIVEN Brushes



on the job for NATIONAL ELECTRIC!

A Pittsburgh "power-driven" brush in operation at the Ambridge plant of the National Electric Products Corporation. Removing burrs, this special brush is on the job every day.

● Like many other leading industries, National Electric put their brushing problems before Pittsburgh's skilled brush engineers. Then Pittsburgh went to work to design and build a special brush for this rough assignment. The brush had to be *stiff* enough to remove burrs and scales. It had to be *tough* enough to penetrate and thoroughly clean the metal. And it had to be *rugged* enough to withstand heavy operation at high speed.

● You, too, can always depend on Pittsburgh to solve your brush problems. Its well-staffed crew of skilled engineers can solve your brush troubles quickly and effectively.

There's a Pittsburgh Brush for Every Industrial Use!

- GLASS
- STEEL
- PLASTICS
- AUTOMOBILE
- RUBBER
- PAPER
- TIRE and RETREADING
- SHOE MANUFACTURING and REPAIRING

In the complete Pittsburgh line are brushes of all types, including "Perfect Balance" sections, wheels and assemblies. Consult the Pittsburgh engineering representative. He will gladly work with you in developing any type of power-driven brushes to meet your particular finishing specifications. Write or phone Pittsburgh Plate Glass Company, 3221 Frederick Avenue, Baltimore—29, Md.

Power Driven BRUSHES

BRUSHES · PAINT · GLASS · CHEMICALS · PLASTICS

PITTSBURGH PLATE GLASS COMPANY

MAXITORQ

One of the newer original equipment installations of Maxitorq Floating Disc Clutches is in the Bodine 42-30 Dial Type automatic Drilling, Tapping and Screw Inserting machine. This high speed machine tool must have positive, dependable power transmission control . . . and a Maxitorq (double dry type) was selected to provide it . . . in this instance for a horizontal tapping spindle.

With Maxitorq there's no heating in neutral . . . patented Maxitorq Separator Springs take care of that. No tools are needed for assembly, adjustment or take-apart. "In" and "out" are positive . . . and the clutch comes to you as an assembled unit, ready to slip onto a shaft. Capacities to 15 H.P. at 100 r.p.m., single or double, wet or dry.

Maxitorq keeps good company. It will pay you to join us.

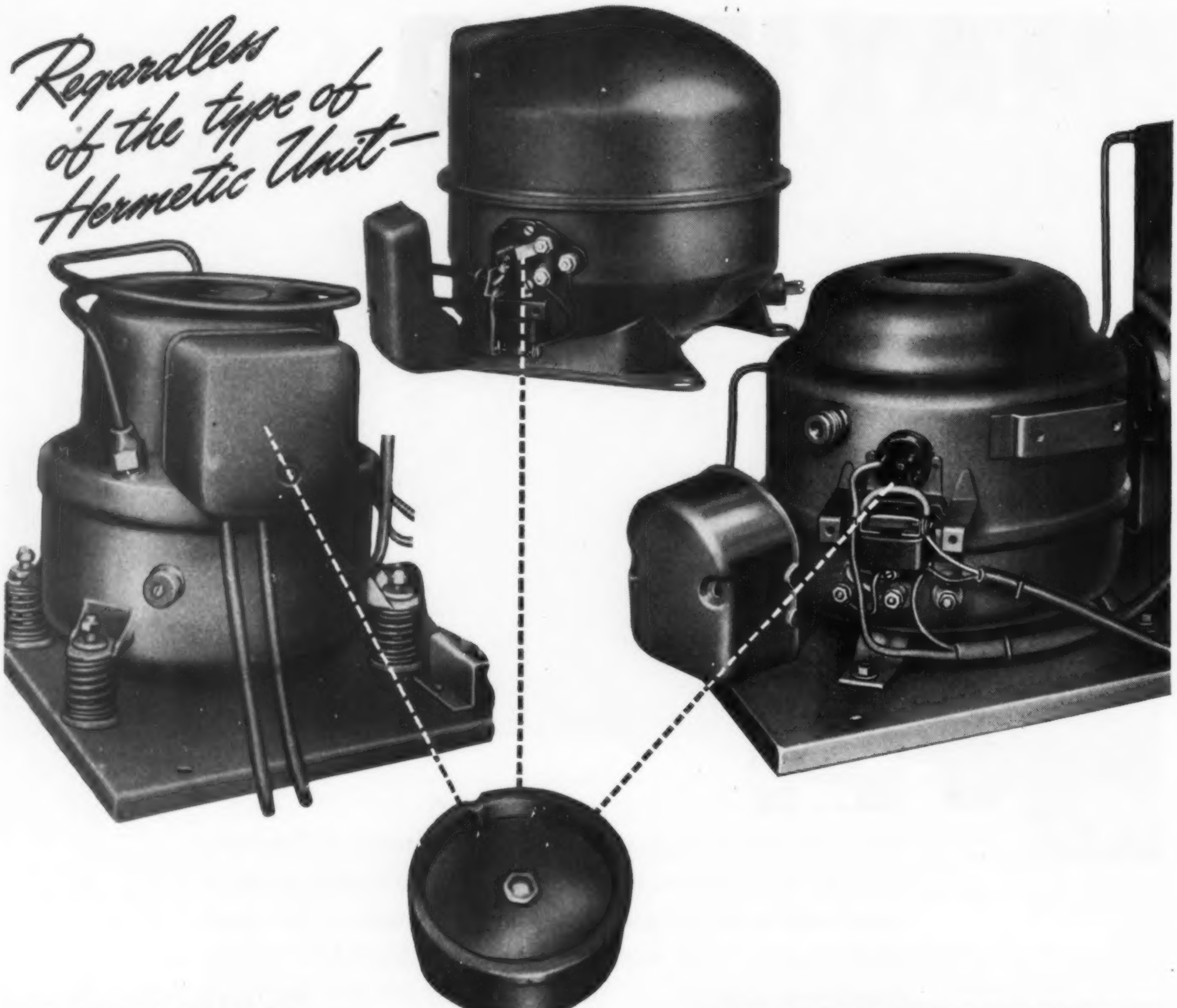
Send for Bulletin MD2

ICJ49

THE CARLYLE JOHNSON MACHINE COMPANY

MANCHESTER • CONNECTICUT

Regardless of the type of Hermetic Unit—



KLIXON *Dome Mounted* PROTECTORS

Provide Positive Motor Protection

- ***Prevent Motor Burnouts***
- ***Reduce Factory Returns***
- ***Enable the Unit to Maintain Refrigeration***

Klixon Motor Starting Relay completes the combination required to start and protect the hermetic motor. Its positive action and long life eliminate starting troubles and make it a fitting companion for the Klixon Protector. Used and recommended by leading refrigeration manufacturers.

Although hermetically sealed units vary in design, they all can have sure motor burnout protection with Klixon dome mounted Protectors.

Mounted on the dome where they follow every temperature change, a Klixon Protector prevents the motor from burning out by shutting "off" the power should the motor become dangerously overheated. When it cools sufficiently, the Klixon Protector snaps the power "on" again automatically enabling the unit to provide refrigeration. And because it is built-in by the hermetic manufacturer, you get a tested and proven combination that will protect the motor for the entire life of the refrigerator.

Don't forget that motors with Klixon Protectors should also be used with open type compressors. Whether you are a manufacturer of hermetic or open type compressors or a user of these units, it will pay you to use Klixon Protectors.

KLIXON

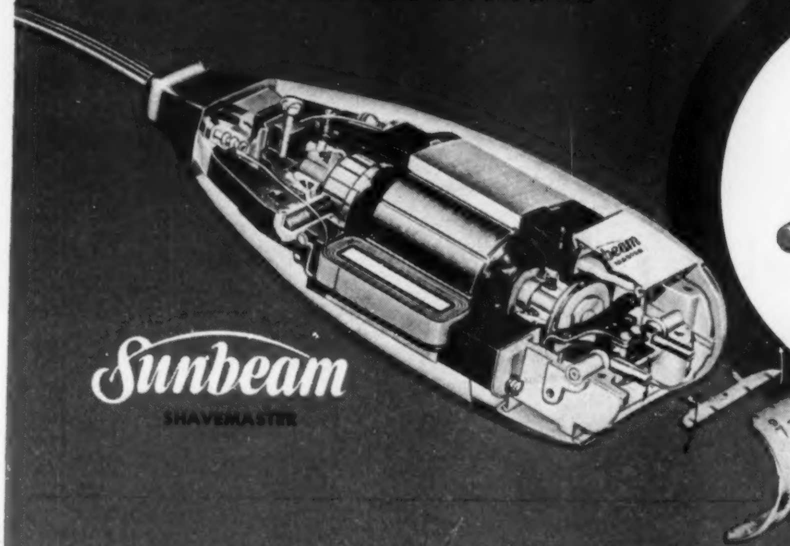
SPENCER THERMOSTAT DIVISION

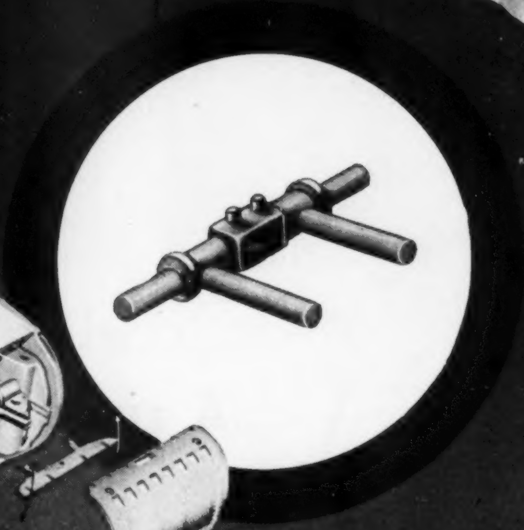
Metals & Controls Corporation, 2502 FOREST ST., ATTLEBORO, MASS.

here's how MICROCASTINGS

make possible faster, smoother shaves

The MICROCAST Shaver Shaft is a vital part in the shaving mechanism of the Sunbeam Shavemaster. This device controls a special cutter which speeds over and back in half circle oscillations with six times greater velocity than blades in other shavers do . . . consequently, the Shaver Shaft is subjected to extreme hard wear and shock.



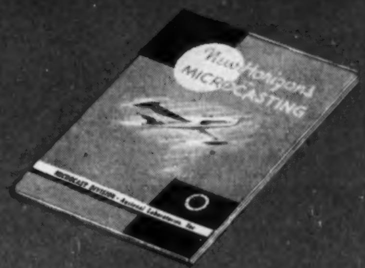


Sunbeam
SHAVEMASTER

MICROCASTING SAVES 3 PARTS

The Shaver Shaft is cast of straight chrome steel eliminating expensive machining costs. Formerly this shaft consisted of three parts . . . *another production case history in which Austenal* MICROCASTINGS *are serving manufacturers by saving them time and money and improving performance of their products.*

Precision Castings From High Melting Point Alloys That Require Little or No Machining—The MICROCAST process offers a flexibility in meeting design problems not possible in the past without pyramiding costs. Small parts of intricate shape can now be specified in a whole new range of high melting point alloys which offer advantages of extreme resistance to heat, wear and corrosion.



NEW CATALOG AVAILABLE

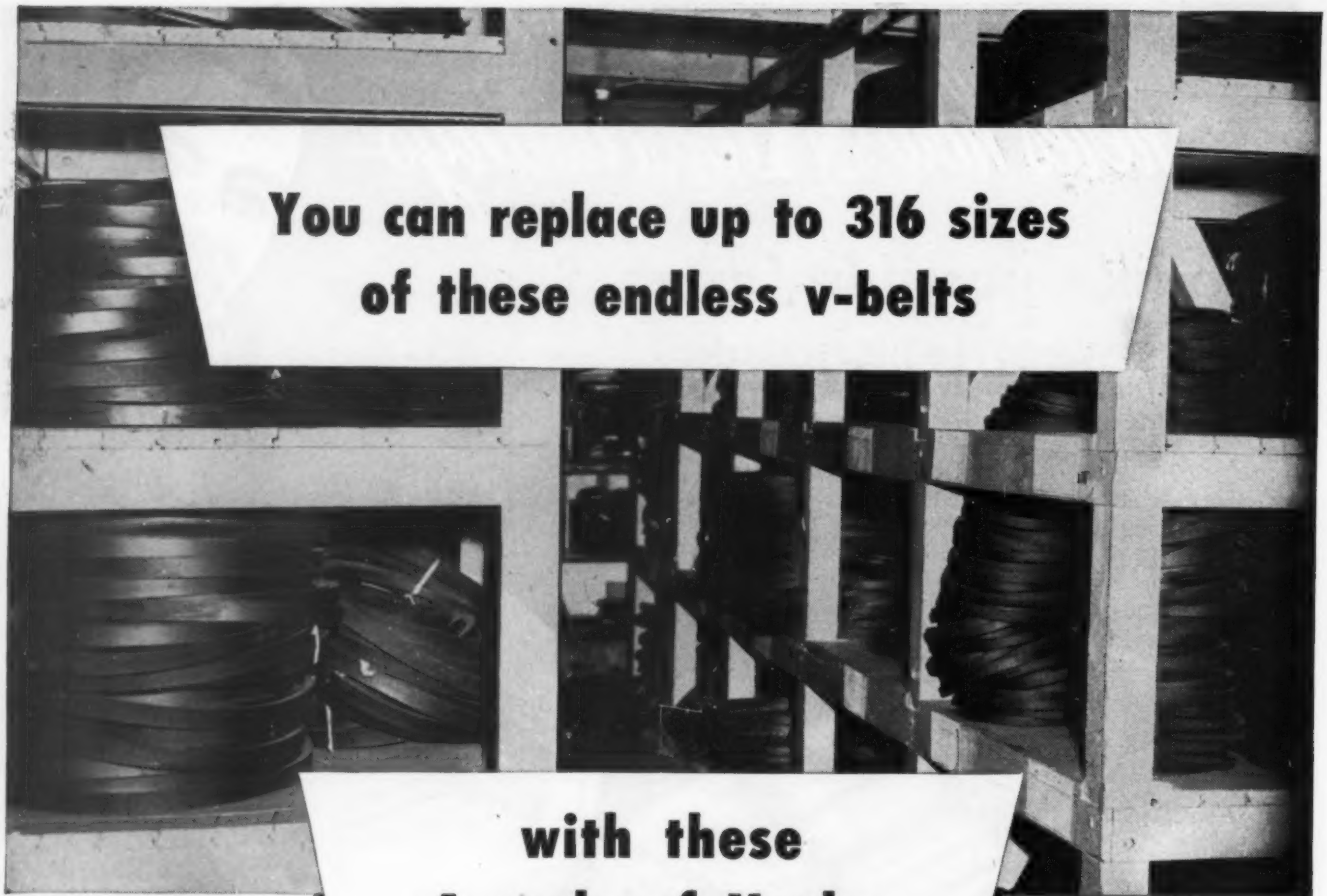
A copy of the new 16 page book, "New Horizons with Microcasting," is yours upon request. It is the most complete report ever published on the subject of the MICROCAST process originated by Austenal Laboratories, Inc. See our catalog in Sweet's File for Product Designers.

MICROCAST PRECISION CASTINGS PROCESS

The name "MICROCAST" is a registered trademark of the Austenal Laboratories, Inc.

MICRO CAST

MICROCAST DIVISION
AUSTENAL LABORATORIES, INC.
224 East 30th Street • New York 16, New York
715 East 69th Place • Chicago 37, Illinois



You can replace up to 316 sizes of these endless v-belts

with these 4 reels of Veelos

Just four reels of Veelos in your stockroom give you replacements for as many as 316 sizes of endless V-belts. Very likely you require less. One reel may give you a complete V-belt inventory. With Veelos, the link V-belt, any length belt is quickly uncoupled, made endless and installed. Belt replacements for any type drive are always immediately available. Standard reels hold 100 feet, save storage space.

Ease of installing Veelos provides substantial savings in installation time. On drives with fixed centers, it is installed without moving the motor or dismantling the machine.

Veelos is available in all standard sizes . . . fits all standard grooves. Sales engineers in principal cities; 350 Veelos distributors throughout the country.

VEELOS
THE LINK
V-BELT

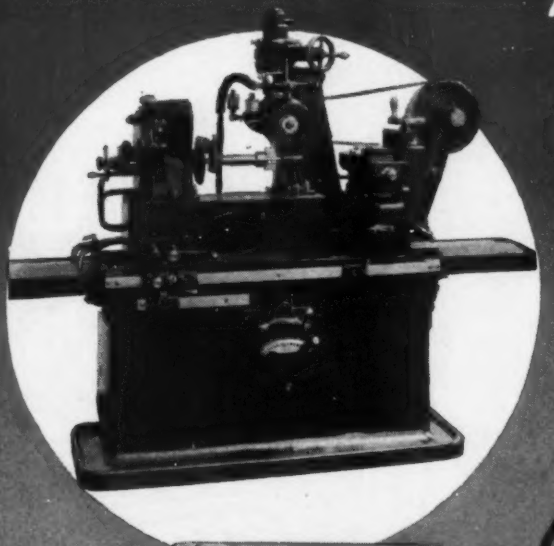
NEW CATALOG gives you all the facts about the important advantages of Veelos and supplies complete engineering data. Fully illustrated, it shows Veelos at work in industry after industry. Your copy sent on request.

MANHEIM MANUFACTURING & BELTING COMPANY
MANHEIM, PENNSYLVANIA

VEELOS is known as VEELINK outside of the United States

ADJUSTABLE TO ANY LENGTH • ADAPTABLE TO ANY DRIVE

We were Proud of this GEARGRIND *30 Years Ago!*



At that time it represented ten years of progress in the art of Formed Wheel Grinding, whereby gears and splines were ground *after hardening* by means of an accurately formed grinding wheel. The contour of the grinding wheel was maintained by frequent dressing, using a special Geargrind wheel trimmer.

BUT PRESENT MODELS EARN *More Money for You!*

About the only resemblance between today's GEARGRIND and its predecessors is the principle involved.

On the GG-10 x 48A shown above tooth spacing is controlled by a precision ground master index plate. The work reciprocates past the grinding wheel on a *short stroke*—just long enough to clear the wheel—and at each reversal point the grinding wheel feeds down. After grinding on one tooth space until a "rough size" is reached, the work is automatically indexed and the next teeth space is ground.

After a predetermined number of teeth have been ground the dresser automatically moves into position to true the grinding wheel. Once the roughing is complete the work is finish ground in the conventional manner, indexing automatically from tooth to tooth.

This method of grinding is 3 to 4 times faster than by any previous machine of comparable capacity, and the many automatic features permit one man to operate more than one machine.

FEATURES

- Automatic grinding wheel feed
- Automatic wheel feed for trueing
- Automatically cushioned trim position
- Automatic lubrication of ways
- Double column support for grinding wheel head
- Axial grinding wheel spindle adjustment
- High work table speeds
- Control panel with interlocked safety features and highly accessible push button and other control
- Index head spindle mounted on tapered roller bearings

The GEAR GRINDING MACHINE COMPANY
DETROIT 11, MICH., U.S.A.

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Spongex takes weariness out of work

For men at machines as well as at desks, for the housewife as well as for women in industry or the professions, *Spongex** sponge rubber reduces shock, vibration, noise and other discomforts . . . takes weariness out of work.

All the cushioning, sound deadening, sealing, insulating properties of rubber have been multiplied in *Spongex* and precisely engineered to a specific job. Whether a simple seat cushion or the life-critical gasket of an iron lung, a bassinet pad for a newborn baby or the window sealing in a stratosphere-flying plane. Everywhere and, seemingly, in almost every product . . . for refrigerator doors, shoe innersoles, typewriter pads, motor mountings . . . *Spongex* is helping product designers make living easier, quieter, more abundant for everyone.

Spongex does a better job because it's made by a company that for 25 years has concentrated exclusively on making rubber do a better job of cushioning, insulating, sealing. You can see the difference, feel the difference, prove the difference such experience makes. You can have generous samples of *Spongex* to experiment with and test for resiliency, cell structure, tensile strength and resistance to temperature extremes, moisture, acids, corrosive vapors, abrasion and aging. Write today, naming your product and problem. Sponge Rubber Products Co., 122 Derby Place, Shelton, Conn. Sales offices in principal industrial centers.

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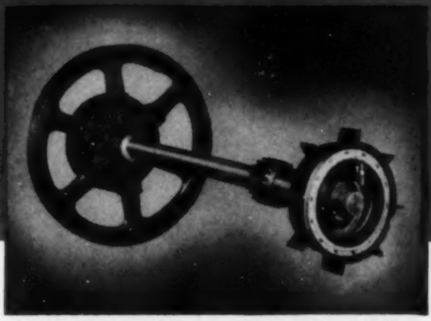
FAWICK-EQUIPPED MACHINES

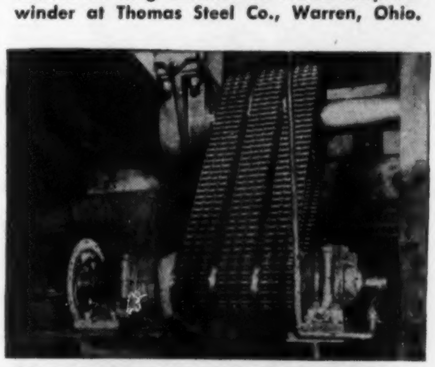
do More Work at Less Cost

Fawick Air-Ring Clutch or Brake Type E



Fawick Airflex Clutch and Fawick Air-Ring brake conversion for Toledo Model 96C Press.

Fawick Air-Ring Clutches on Plated Strip Rewinder at Thomas Steel Co., Warren, Ohio.



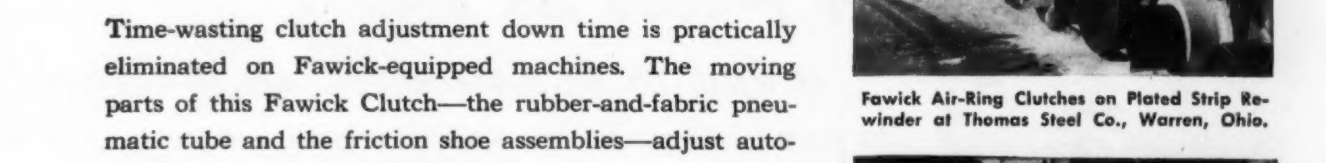
Triple Fawick Air-Ring Clutch on Head Rig Drive to Sumner 9' Head Mill at Universal Box Co., Ltd.

Time-wasting clutch adjustment down time is practically eliminated on Fawick-equipped machines. The moving parts of this Fawick Clutch—the rubber-and-fabric pneumatic tube and the friction shoe assemblies—adjust automatically and compensate for wear.

The smooth engagement action of this Fawick Clutch eliminates sudden shock loads which damage machinery. Controlled torque starting can be obtained with a simple modulating air valve. This type Fawick Clutch is ideally suited to continuous slip applications.

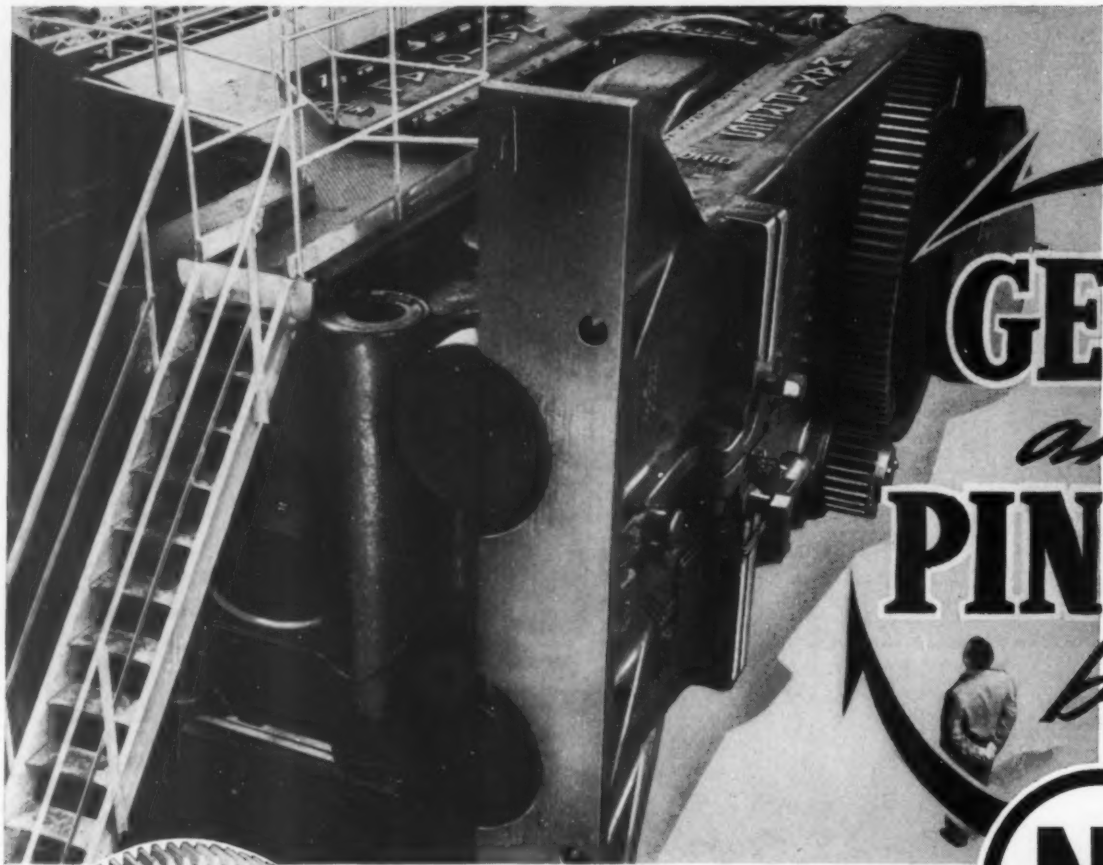
For specific recommendations for your machines, write to our Engineering Department today. Address Dept. MD.

FAWICK *Airflex* CO., INC.
9919 CLINTON ROAD — CLEVELAND 11, OHIO



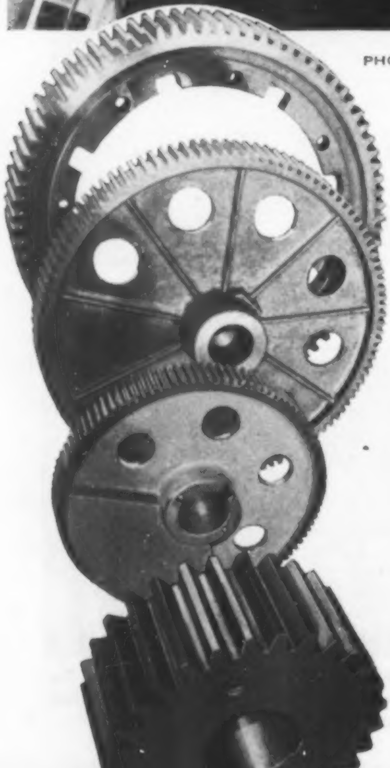
Expanding under force of compressed air, the rubber-and-fabric tube smoothly engages the clutch with the precise degree of grip required by the job.

Releasing air through the instant-acting Fawick Quick Release Valve promptly and fully disengages the clutch, lets it ride completely free, without drag, or mechanical contact.



GEAR *and* PINION *by* NE

PHOTO COURTESY OF THE NATIONAL MACHINERY CO., TIFFIN, OHIO



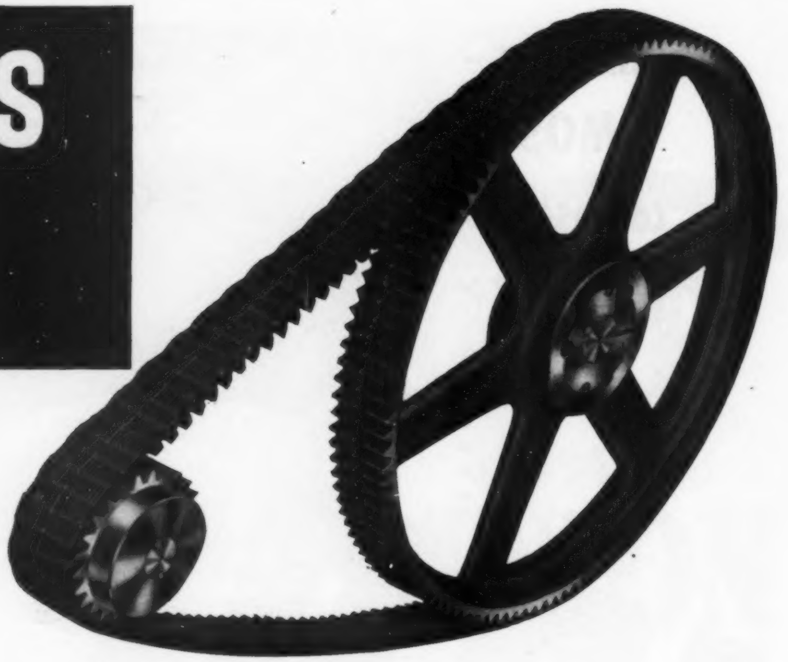
A Press so big..
it had to be assembled on it's back!

HERE is the Neloy Alloy Cast Steel Gear and pinion drive of a No. 10 National Machinery Company Maxipres so big it had to be assembled on its back. The large gear is Neloy Molybdenum, Normalized; 190-220 Brinell rough weight 26,130 pounds. The pinion is Neloy No. 3; Alloy Steel, quenched, 202-240 Brinell rough weight 3,480 pounds. Both are 4 inch circular pitch, 16 inch face. Gearing such as this, while not routine production, is taken in stride at National-Erie Corporation where your specification requirements are completely controlled from the raw material to the finished product. Neloy or Neloy Moly, spur, bevel, mitre, Sykes Herringbone, finished gears or blanks are specialties of our Foundries and Machine Shops . . . Send your specifications to us. Bulletin No. 9 gives full details. Write for it.

NATIONAL ERIE CORPORATION

ERIE, PENNSYLVANIA • U. S. A.

ENDLESS STORY



Morse Silent Chain Drives

THE STORY of Morse Silent Chain Drives is an endless one of efficiency, low cost and positive power transmission.

Perhaps the most effective known means of transmitting power between shafts, Morse Silent Chain is quiet, smooth, and dependable. Considered by engineers as flexible gearing, it has been used to transmit 5000 h.p. in a single drive; speeds have sometimes exceeded 8000 FPM. At high velocities, Morse Silent Chain Drives utilize centrifugal force to distribute driving effort over a greater number of teeth, reducing impact, wear, and noise.

Part of the story of the operating economy and long life of Morse Silent Chain Drives is found in the famous frictionless rocker joint. Employing essentially a simple rocking-chair action, Morse Silent Chain contact is confined to rolling instead of sliding action. Less heat is developed, enabling the drive to transmit heavy loads at high speeds without overheating.

Simple to connect or disconnect, Morse Silent Chains can be installed or removed without dismantling machines on which they are used. Chain length is easily and quickly adjusted for any center distance, and speed ratio changes can be readily accomplished. The initial cost of Morse Silent Chain Drives is surprisingly low, and their high efficiency and frictionless joint design assures the lowest operating cost per hour and low maintenance outlay.

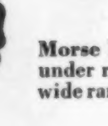
Why not check the Morse Silent Chain story more completely? Write for catalog C71-48. Morse Chain Company, Dept. 290, Detroit 8, Michigan.

★ ★ ★

Morse Roller Chain Drives • A low-cost, positive, efficient, flexible drive for use under rigorous operating conditions, Morse Standard Roller Chain is applicable to a wide range of installations and is available in all American Standard pitches and widths.

Morflex Couplings

Roller Chain Couplings

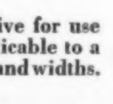


Silent Chain Drives

MORSE

MECHANICAL POWER TRANSMISSION PRODUCTS

A PRODUCT OF B-W BORG-WARNER



Morflex Radial Couplings

MORSE CHAIN COMPANY • DETROIT 8, MICHIGAN

Get a better tubing score with Bundyweld*

Get a better score on *1)* production costs, *2)* quality, and *3)* time and labor savings by checking Bundyweld Tubing.

Bundyweld *and only Bundyweld* is double-walled from a single strip of metal. Copper-brazed at all points of wall contact, thin, extra-strong Bundyweld assures less leakage under pressure, less breakage under short-radius bends. It is readily fabricated, lightweight, and easy to handle.

Here are only a few of the industries which have made Bundyweld the standard for many of their tubing applications:

Automotive—fuel, hydraulic, vacuum, and brake lines.
Refrigeration—condenser, evaporator, and compressor tubing parts.
Range—supply lines, flash and pilot tubes.
Radiant heating—panel grid tubing.

Bundyweld for television antennas; beer coils of special Bundyweld Nickel; toy baby carriages, whistling gas-tank signals—these are just a few of the applications of Bundy Tubing that are making profits for their manufacturers.

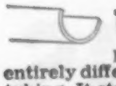
If you have a design or production problem, or a new idea for tubing, why not contact Bundy engineers to help you work it out? Just call or write: *Bundy Tubing Company, Detroit 14, Michigan.*

BUNDY TUBING

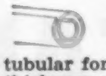
ENGINEERED TO YOUR EXPECTATIONS

* REG. U.S. PAT. OFF.

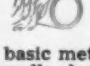
WHY BUNDYWELD IS BETTER TUBING



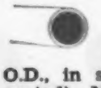
1 Bundyweld Tubing, made by a patented process, is entirely different from any other tubing. It starts as a single strip of basic metal, coated with a bonding metal.



2 This strip is continuously rolled twice laterally into tubular form. Walls of uniform thickness and concentricity are assured by close-tolerance, cold-rolled strip.



3 Next, a heating process fuses bonding metal to basic metal. Cooled, the double walls have become a strong ductile tube, free from scale, held to close dimensions.



4 Bundyweld comes in standard sizes, up to 5/8" O.D., in steel (copper or tin coated), Monel or nickel. For tubing of other sizes or metals, call or write Bundy.

BUNDY TUBING DISTRIBUTORS AND REPRESENTATIVES

Cambridge 42, Mass.: Austin-Hastings Co., Inc., 226 Binney St. • *Chattanooga 2, Tenn.:* Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. *Chicago 32, Ill.:* Lapham-Hickey Co., 3333 W. 47th Place • *Elizabeth, New Jersey:* A. B. Murray Co., Inc., Post Office Box 476 • *Philadelphia 3, Penn.:* Rutan & Co., 404 Architects Bldg. • *San Francisco 10, Calif.:* Pacific Metals Co., Ltd., 3100 19th St. • *Seattle 4, Wash.:* Eagle Metals Co., 3628 E. Marginal Way • *Toronto 5, Ontario, Canada:* Alloy Metal Sales, Ltd., 881 Bay St.

BUNDYWELD NICKEL AND MONEL TUBING IS SOLD BY INTERNATIONAL NICKEL COMPANY DISTRIBUTORS IN PRINCIPAL CITIES.

HELPFUL LITERATURE

FOR DESIGN EXECUTIVES

70. Zinc
New Jersey Zinc Co.—8-page illustrated pamphlet "Horse Head Bulletin" outlines use of zinc in conveyor belting utilized in 'rubber railroads', in automatic phonograph and other applications.

71. Synchronous Timing Motor
R. W. Cramer Co.—4-page illustrated bulletin No. 10A explains construction of permanent magnet type synchronous timing motor which is self-starting, runs at slow speed and operates in any position.

72. Variable Speed Drives
American Pulley Co.—4-page illustrated bulletin No. RWB-48 describes Wedgbelt wide range, adjustable diameter, variable speed drives designed to utilize multiple R-section V-belts.

73. Two-Speed Gear Head
Olson Industrial Products, Inc.—4-page illustrated folder "Two Speed Gear Head" deals with unit which can be attached to any type of portable vertical milling head. With six-step pulley, it provides twelve speeds from 45 to 4500 revolutions per minute; and with five-step pulley, it furnishes ten speeds.

74. Industrial Transmissions
Drive-All Mfg. Co.—6-page illustrated folder deals with 35 different models of industrial transmissions which are available having from ½ to 30 horsepower capacity.

75. Stainless Pipe & Tube
Babcock & Wilcox Tube Co.—4-page illustrated technical publication No. 132 provides condensed data on corrosion resistance, creep strength, oxidation resistance, mechanical properties, machinability, welding characteristics and physical properties of Croloy 18-8Cb stainless steel pipe and tubing.

76. Rubber Products
B. F. Goodrich Co.—28-page illustrated vest-pocket size booklet No. 5-7286-G1 lists complete line of industrial rubber products such as flat transmission belting, conveyor belting, V-belts and sheaves, multi-V-belts and all types of hose and couplings.

77. Mercury Clutches
Automatic Products Corp., Mercury Clutch Div.—Illustrated data sheet reveals design advantages of mercury type clutches and discusses specifications of standard models as well as special types. Numerous applications are suggested.

78. Stainless Steels
Allegheny Ludlum Steel Corp.—39-page illustrated catalog "Allegheny Metal In Chemical Processing" provides facts and figures on use of stainless steel in chemical processing, acid manufacture, general processing, plastics manufacture, dye industry and soap making industry.

79. Mechanical Seals
Durametallic Corp.—4-page illustrated folder No. 427 deals with Dura Seal type P. S. mechanical seals designed for pressures up to 600 pounds per square inch. Units can be used with light hydrocarbons at temperatures up to 250° F. They rotate with shaft.

80. Pressure Control Valves
Vickers Inc.—12-page illustrated catalog covers unloading, sequence, overload relief and counterbalance Hydro-Cushion type hydraulic valves in sizes from ¼ to 1¼-inch pipe sizes.

81. Electrodes
Ampco Metal, Inc.—4-page illustrated bulletin No. W-19 suggests arc welding electrodes for joining metals. Chart lists 31 alloys and shows which of five bronze electrodes is best suited for certain applications.

82. Electrical Connectors
Mines Equipment Co.—8-page illustrated publication No. MC-108 contains information on electrical connectors, round plugs and receptacles, oval plugs, lamp sockets, distribution centers and cable vulcanizers.

83. Enclosed Motors
Burke Electric Co.—4-page illustrated folder No. NAF-1 describes large totally-enclosed fan-cooled squirrel-cage induction motors available in sizes from 250 to 500 horsepower.

84. Standard & Special Motors
Brown-Brockmeyer Co. — 6-page illustrated bulletin No. 5000 describes single-phase, split-phase and polyphase; geared head; explosion-proof and special motors available in sizes from 1/6 to 30 horsepower.

85. Ball Bearing
Norma-Hoffmann Bearings Corp. — 28-page illustrated booklet "The Norma-Hoffmann Cartridge Ball Bearing" covers applications, dimensions, load rating, dirt protection and lubrication of this versatile bearing.

86. Cast Iron Pulleys
Pyott Foundry & Machine Co.—10-page illustrated catalog No. 60 presents data and current prices of split and solid cast-iron pulleys of single and multiple arm types, four-ply rubber lagging, and ball bearing loose pulleys.

87. Hydraulic Valves
Denison Engineering Co.—18-page illustrated bulletin VD-2 deals with ¾-inch HydrOILic four-way valves which are hydraulically balanced, directional controls for 2500-pound per square inch pressure duty.

88. Automatic Stud Welding
Morton Gregory Corp., Nelson Stud Welding Div.—28-page illustrated manual outlines automatic electric-arc stud welding procedure, discusses applications and tabulates data.

89. Metal Forming Dies
Cyril Bath Co.—36-page illustrated catalog D 22 contains information on metal forming dies, cabinet forming machinery, Sturdybender presses, and special machinery for hot and cold forming.

90. Surface Preparation
Sherwin-Williams Co. — 14-page illustrated booklet "Metal Preparation for Industrial Finish" discusses purpose of surface preparation, cleaning methods, metal treatments and cleaning-treatment systems.

91. Rubber Expansion Joints
Garlock Packing Co. — 8-page illustrated booklet "Garlock Rubber Expansion Joints" describes spool type rubber expansion joints for installation in pipe lines to relieve stresses and strains in piping and equipment.

92. Refrigerator Sealers
Presstite Engineering Co.—48-page illustrated catalog "Refrigerator Sealers" covers Permagum, mastic, thermal mastic, wood and gasket sealers and molded cork asphalt insulators.

93. Brass Tube Fittings
Imperial Brass Mfg. Co.—Illustrated pocket-size folder "Handy Data on Brass Fittings" describes and gives size and price listings of compression, flared, inverted flared, Flex, Hi-Duty, threaded sleeve and brass pipe fittings.

FOR MORE INFORMATION

on developments in "New Parts" and "Engineering Department" sections—or if "Helpful Literature" is desired—circle corresponding numbers on either card below.

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94. Induction Heating
Ohio Crankshaft Co., Tocco Div.—40-page illustrated catalog 22 is entitled "Tocco Induction Heating." Principles of induction heating, typical results of induction hardening and heat treating, use of induction heating for forming and forging, induction annealing, and induction brazing and soldering are some of subjects covered in detail.

95. Gear Motor
Janette Mfg. Co.—Brochure No. 3-200 describing type UW gear motor includes dimensions; assembly positions; and tabulation of torques, speeds, gear ratios and overhung load capacity.

96. Air Cylinders
Hanna Engineering Works—Slide rule type Air Cylinder Selector facilitates determination of cylinder diameter, required gage pressure, force, cubic feet of free air required per inch of stroke, cycles per minute or seconds per stroke, pressure drop, pipe size, horsepower required and other factors.

97. Air Compressors
DeVilbiss Co. — 4-page illustrated folder "Now, Even More Air for Your Money" deals with four-cylinder V-type two-stage air-cooled compressors rated at 7½, 10 and 15 horsepower.

98. Industrial Wheels & Hubs
Kelsey-Hayes Wheel Co., Franch & Hecht Div.—36-page illustrated catalog "French and Hecht Wheels & Hubs" shows and lists specifications of disk wheels, special stampings, cast iron wheels, custom-built steel spoke wheels and parts.

99. Extruded Shapes
Titan Metal Mfg. Co.—4-page illustrated folder "Titan Extruded Shapes" describes brass and bronze extrusions and gives chemical composition and physical properties of nine alloys commonly used.

100. Adjustable Speed Drives
Reliance Electric & Engineering Co.—8-page illustrated bulletin No. 311 presents latest developments in V-S electric adjustable-speed drives for alternating current circuits. They range from 1 to 200 horsepower in size.

101. Clutches
Auburn Clutch Co.—64-page illustrated catalog No. 101 presents information on car, truck, bus and wheel tractor clutches, clutch covers, clutch plates and engine power take-offs.

102. Single Bearing Motors
Redmond Co. — 4-page illustrated folder "New Redmond MonoMotors" describes single bearing, shaded pole alternating current motors for refrigeration, air conditioning, heating, ventilating and other low range power applications.

103. Stainless-Clad Steels
Lukens Steel Co.—16-page illustrated bulletin No. 338 describes line of stainless-clad steels and gives application data on most important types of materials. Several pages of corrosion data, size and weight tables and pictures of equipment are included.

104. Lubrication Control
Engineered Products, Inc.—Illustrated data sheet No. 7132 presents information on OilTrol device for lubrication control. Unit is hydraulic-electric diaphragm-activated switch that controls ignition current or causes warning devices to respond when engine oil pressure is below normal.

105. Electric Tachometers
Metron Instrument Co.—4-page illustrated folder No. 104 describes new, low-cost electric tachometers. Several types of heads are shown for industrial, marine, diesel and aircraft applications and for direct head coupling. Ranges are from 1 to 100,000 revolutions per minute.

106. Magnetic Subassemblies
General Electric Co.—4-page illustrated booklet No. CDM-16 explains how permanent magnet subassemblies eliminate assembly line rejects, high cost of test equipment, breaking and chipping losses and expense of shipping semifinished magnets.

107. Embossed Metals
Rigidized Metals Corp.—1-page illustrated "Idea Chart" lists applications of design-strengthened Rigidized metals which are available in wide range of texture patterns in stainless steel, aluminum and other metals.

108. Cast Bronze Bushings
Moccasin Bushing Co.—46-page illustrated catalog "Moccasin Cast Bronze Oil-Distributing Bushings" describes bushings so designed that oil is uniformly distributed on bearing surface; contains price list of standard cast bronze bushings and bearings; lists sizes of machined bronze bars; and includes engineering data chart No. 429 which covers chemical compositions, physical properties and comparative society and government specifications.

109. Tool Steels
Carpenter Steel Co.—Wall chart measuring 21 x 31 inches contains colored digram and data to aid in selection of tool steels and for quick identification of different grades of tool steel bars.

110. Manufacturing Facilities
R. C. Mahon Co.—40-page illustrated brochure "Two Modern Plants House the Seven Divisions" shows equipment and facilities available for design and manufacture of heavy industrial machinery and components, steel doors, structures, steel decks and walls, and sheet metal products.

111. Aluminum Castings
Acme Aluminum Foundry Co.—16-page illustrated booklet shows and discusses facilities for engineering and production of aluminum and magnesium castings. Composition and properties are charted and typical castings depicted.

112. Filtering Equipment
Air-Maze Corp.—illustrated folder describes cleanable type Kleenflos bronze air filters for heating and air conditioning applications, tank vent flame arresters, air line filters and panel filter assemblies for large engines and compressors.

113. Industrial Radiography
Eastman Kodak Co., X-Ray Div.—16-page illustrated bulletin No. Fl-3 is entitled "Kodak Materials and Accessories for Industrial Radiography." Included in listings are films, exposure holders, intensifying screens, chemical processing preparations, darkroom accessories and viewers. Guidance is given in chart form for exposing different types of x-ray films.

114. Bronze Bushing Stock
Shenango-Penn Mold Co.—6-page illustrated folder lists stock sizes of tubular and solid bronze bars which are centrifugally cast and chill cast for maximum service.

115. Jig & Fixture Parts
Noble & Stanton, Inc.—46-page illustrated catalog "Component Parts of Jigs and Fixtures" gives complete details and dimensions of Chrome Plated line which includes screws and bolts, clamps of all types, knobs, feet, adjusting nuts, rest buttons, V-blocks, angle plate fixtures and washers as well as many other parts.

116. Dry Type Transformers
Westinghouse Electric Corp.—12-page illustrated bulletin No. B-4009 describes complete line of dry type transformers designed to provide efficient operation of motors, lights and other electrical equipment requiring 120-240 volts alternating current. Standard ratings range from 0.025 to 2500 kilovolt-amperes single phase and 9 to 3750 kilovolt-amperes three phase.

117. Industrial Finishes
Sherwin-Williams Co.—8-page illustrated bulletin "Ajax Insulating Varnishes" contains information on several types of varnishes for electrical insulation applications, and tabulates data to direct their use.

118. Steel Tubing
Ohio Seamless Tube Co.—12-page illustrated guide booklet cites advantages, applications and size ranges of various types of Ostuco tubing which includes mechanical seamless, aircraft seamless, electric resistance welded, forged and fabricated tubing.

119. Chemical Products
Hercules Powder Co. — 20-page illustrated booklet "Hercules Products" describes over 100 chemicals as to makeup, uses and potential applications. Cellulose chemicals, synthetic resins, rosins, terpene solvents and chemicals, chlorinated products, casein, explosives and other chemicals are covered.

120. Pneumatic Feeders & Holders
Mead Specialties Co.—Three illustrated data sheets Nos. 36-36a, 39-40 and 41-42 describe pneumatic drill press feed, rotary work feeder, tube drilling set-up and special wire-forming machine made up of work feed and cylinder.

M. D. Numbers

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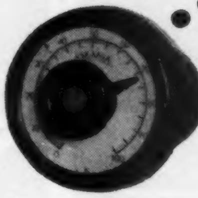


TRANSMITTER

Operate VALVES, THROTTLES, MACHINES, VARIABLE DRIVES . . .

Up to 1,000 FEET AWAY

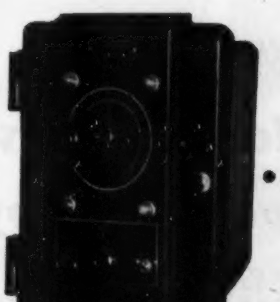
SIMPLY, ACCURATELY, WITH THE ASKANIA ELECTRONIC SERVO SYSTEM

Consider the advantages of operating mechanisms from a remote point up to one thousand feet away — for equipment in a dangerous, inaccessible or inconvenient location. A central control system for several of the receivers is possible. Precise operation is assured by the system's accuracy of ¼ of 1%.

Operating on a standard 115 volt a-c current, the standard receiver shown in the illustration can offer torques up to 220 pound-inches. With the addition of a hydraulic cylinder, torques as high as 7,500 pound-inches can be achieved.

Almost any combination of the three units can be devised to permit multiple networks of transmitters and receivers.

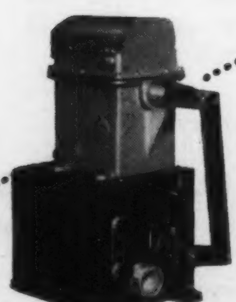
All components of the system are constructed for heavy duty, rugged industrial operation. Dust-proof, cast metal cases withstand shocks, vibration and corrosion. All circuits and tubes can be reached easily without impairing the operation or original installation. Only two electrical supply line connections are needed for the entire system. Write for full information.



AMPLIFIER

Accurate, powerful, simple remote control of dampers, valves, gates, throttles, pumps, machine tools, variable speed settings . . . can be achieved with a combination of the Askania Electronic System components shown in the illustration. A position signal selected at the transmitter or amplifier either manually or by means of cams, gears, or linkages causes the receiver crank arm to change position over a 90 degree arc.

RECEIVER



ASKANIA Controls

Send for Bulletin 138 A

ASKANIA REGULATOR COMPANY

A Subsidiary of General Precision Equipment Corporation

254 EAST ONTARIO STREET CHICAGO 11, ILLINOIS

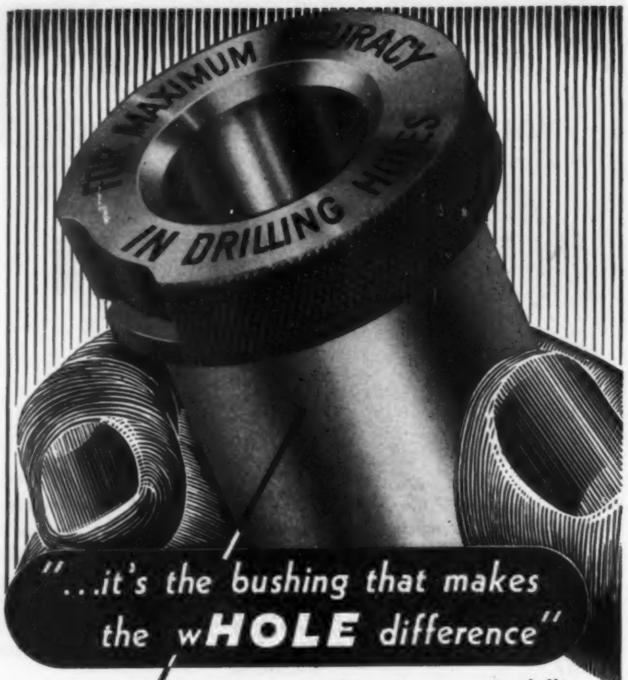
This flange-mounted, slip-ring motor with mounted disc brake is another example of a Cleveland Electric Motor built to customer's specifications—designed to give dependable service under rugged operating conditions. Totally enclosed housing of weatherproof construction guards against dust, splashing and dripping. Depending upon type of controls employed, this versatile motor can be used on crane and hoist applications on hard-to-start loads, or for speed regulation. Specifications: Type 525W, 2 H. P., 1200 RPM, 3 phase—also obtainable in squirrel cage design. This precision-built, compact unit is ideal for installation in close quarters. It will deliver many hours of economical, trouble-free operation.

Let us solve your electric power problems with motors from our standard line or designed to your specific requirements. You'll be interested in our prices and ability to deliver fast. Write today for complete information.

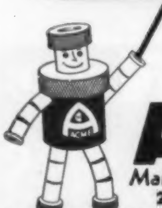
SPECIAL MOTORS FOR SPECIAL PURPOSES

CLEVELAND ELECTRIC MOTOR CO.

5213 CHESTER AVE. • CLEVELAND 3, OHIO



"...it's the bushing that makes the wHOLE difference"



To maintain maximum accuracy in drilling operations, use the bushing that's precision made for the job...use Acme. Write for catalog.

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Makers of Hardened and Ground Precision Parts

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THE SERVICE SHOP TO INDUSTRY FOR MORE THAN 25 YEARS

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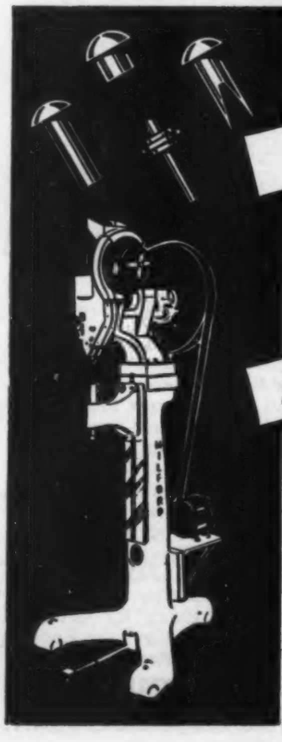

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RIGHT RIVETS

Select exactly the right semi-tubular, split rivet, or cold-headed fastener from Milford's complete line. You'll find it pays in every way!

RIGHT MACHINE

Then use the right rivet setting machine for your application. One of Milford's 15 basic machines is sure to solve your particular problem . . . and slash your production costs!

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MILFORD RIVET & MACHINE COMPANY

HATBORO, PENN.
ELYRIA, OHIO
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FLEXLOC ONE-PIECE SELF-LOCKING NUTS

"WON'T SHAKE LOOSE"

Pat'd & Pats. Pend.

REGULAR

THIN

The one-piece, all-metal, resilient "Flexloc" is becoming widely accepted, because it is processed to have an exceptionally uniform torque, and because it is a stop, a lock and a plain nut all in one.

All its threads are "live" and load-carrying; "Flexloc" accommodates itself to a wide range of thread tolerances, and can be used over and over again without losing much of its torque . . . . is not affected by temperatures commonly met within the industrial field of Mechanical Engineering . . . and being a "stop" nut, it stays locked in any position on a threaded member . . . and last, but not least—it won't shake loose!

The *Thin* "Flexloc" has become very popular because its *tensile* is so high and the space it occupies so small.

Sizes from #6 to 2" in diameter—in "regular" and "thin" types—in NC and NF thread series. Write for *"Flexloc" Catalog.*

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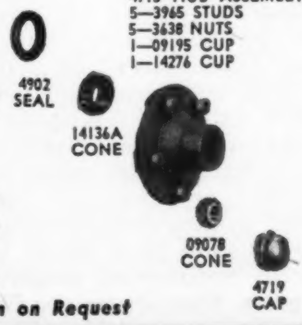

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DIVISION
KELSEY-HAYES WHEEL COMPANY
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Wheel Builders Since 1888

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● The renown of Imperial as the finest in Tracing Cloth goes back well over half a century. Draftsmen all over the world prefer it for the uniformity of its high transparency and ink-taking surface and the superb quality of its cloth foundation.

Imperial takes erasures readily, without damage. It gives sharp contrasting prints of even the finest lines. Drawings made on Imperial over fifty years ago are still as good as ever, neither brittle nor opaque.

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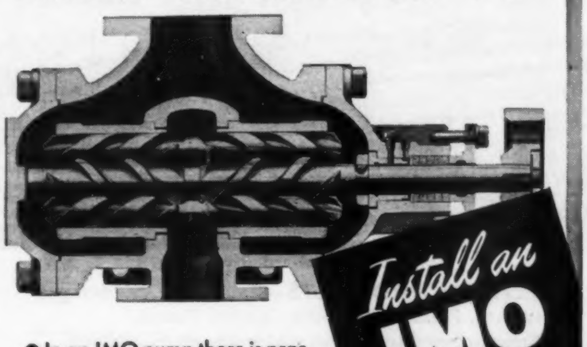

Install an **IMO**

● In an IMO pump there is practically nothing to get out of order or to adjust. The IMO has only three moving parts—a power rotor and two idler rotors. It has no reciprocating members, no valves, no synchronized mechanisms, no pilot gears and no sliding vanes.

IMO pumps can be furnished for practically any capacity and pressure required for oil, hydraulic-control fluids and other liquids.

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BULLETIN 200 on automotive electrical control devices for..


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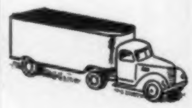
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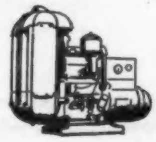
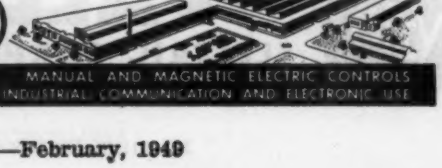

Gas Engine Auxiliaries

RBM

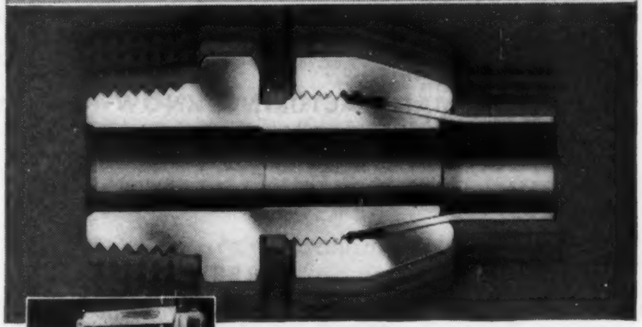


MANUAL AND MAGNETIC ELECTRIC CONTROLS
FOR AUTOMOTIVE INDUSTRIAL COMMUNICATION AND ELECTRONIC USE

Vibration under high pressure?

Superseal

Flared Tube Fittings make light wall tubing practical




Jaeger Mfg. Co. compressors have Superseal Fittings.

Would you switch to light wall tubing if you could obtain fittings that withstand vibration under high pressure?

Then you'll be interested in Superseal Flared Tube Fittings which are now standard equipment on steam generators and on air compressors with pressures running up to 600 P.S.I. The same fittings in an Underwriters' Laboratories test maintained a leakproof joint under pressures up to an amazing 8090 pounds, at which pressure the steel tubing split. Grinnell Company, Inc., Providence 1, R. I.

SUPERSEAL FEATURES SAVE TIME, SAVE MONEY!

PERMANENTLY LEAKPROOF JOINTS unaffected by vibration.

FOR ANY TUBING, including welded steel tubing, using a single flare.

LONG, SMOOTH, TAPERED 10° FLARE on fitting and inside of self-aligning nut hold tubing securely.

NO SHEARING ACTION to injure tubing at point of flare when nut is tightened. Tubing actually reinforced.

REPEATED DISCONNECTIONS without injury to tubing.

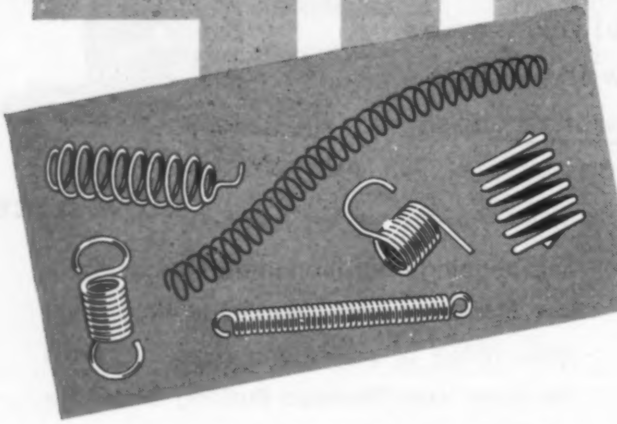
PRODUCTION FLARING up to 2000 a day on inexpensive flaring machine.

STOCKED IN BRASS AND STEEL, 1/8" to 1/2".

99 YEARS PIPING

GRINNELL

49 TIPS on your '49 SPRINGS



In fact, there are more than 49 tips — influencing factors that will enable you to select the most practical, economical springs for your products this year.

You would be surprised at the number of manufacturers that continue through "habit" to use certain springs. The springs do a fine job so why change, they say.

The answer is that another type spring might serve the purpose equally as well — or better. It could be more economical, could improve product efficiency, could be supplied in desired quantities and could be delivered on time.

But these are the things that the Lewis Spring Engineer can quickly tell you.

Lewis Engineers have saved manufacturers hundreds, and even thousands of dollars, by helping them select the *right* springs at the *right* price. These men base their suggestions on years of experience in spring design, manufacture and applicability to products.

There is a Lewis representative near you who will be glad to offer his recommendations. There's no obligation and you may find his suggestions very profitable for you.

LEWIS SPRING & MFG. CO.
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Lewis PRECISION SPRINGS

THE FINEST LIGHT SPRINGS AND WIREFORMS OF EVERY TYPE AND MATERIAL

on COOLANT problems
HERE'S THE ANSWER!

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To solve your coolant problems, both as to efficiency and economy, send for Ruthman Machinery's new catalog today. You will find it invaluable in choosing the correct coolant pump for your metal working machines.

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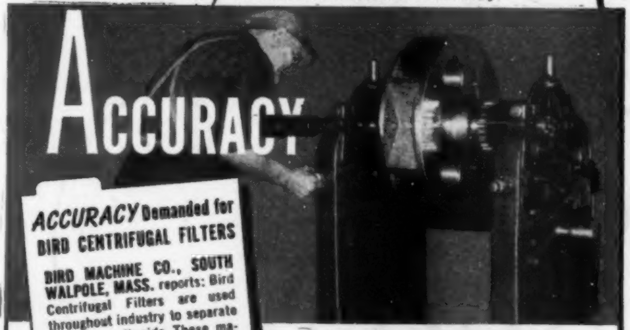
SB-1 CONTROL AND TRANSFER SWITCH

Over 10,000 circuit-sequence combinations are possible with this versatile control and transfer switch. Rated up to 20 amperes at 600 volts a-c or d-c. Compact, sturdy construction. Mount on panels ⅛ to 2 inches thick. Easy to order, too . . . see your G-E sales representative about the SB-1. Write for bulletin GEA-4746. *Apparatus Department, General Electric Company, Schenectady 5, New York.*

GENERAL ELECTRIC

CASE REPORT No. 53 from a series of actual cases recording the successful application of "BEAR" DY-NAMIC BALANCING to Industry.



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BIRD MACHINE CO., SOUTH WALPOLE, MASS. reports: Bird Centrifugal Filters are used throughout industry to separate solids from liquids. These machines must be **precision-built** because they handle solids as fine as a fraction of a micron or tonnages as high as 60 tons per hour. All rotating parts are "Bear" Dy-Namically Balanced . . . we obtain accurate results as well as efficient production.

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- *Speeds Up Production*
- *Sells MORE of YOUR Products*

"Bear" Dy-Namic Balancing is making its weight felt in every phase of industry by helping to increase sales appeal and adding value to hundreds of products...from tiny electric motors to washing machines and railroad wheels. By the revolutionary "Bear" Method both Dy-Namic and Static Balance are attained in one time-saving operation, which need not interrupt routine production and may be installed with low initial capital investment.

Investigate the many production advantages and sales gains made possible by "Bear" Dy-Namic Balancing--GET ALL THE FACTS in this FREE 22-page DY-NAMIC BALANCING MANUAL. Write Bear Mfg. Co., Dept.M-4, Rock Island, Ill.

BEAR STATIC AND DY-NAMIC BALANCING MACHINES

Trade Mark Registered U. S. Patent Office

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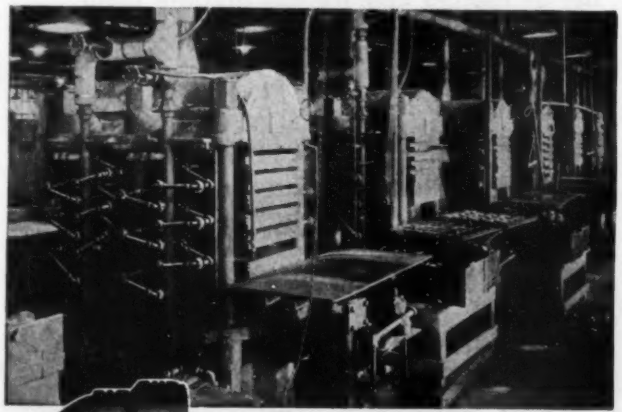
WHERE PIPING MOVES—



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offer the Flexibility of HOSE . . . the strength of PIPE

TYPE "F"

Dependable FLEXO JOINTS assure unrestricted flow in all positions, give 360° range of swivel movement for pressures from gravity up. Completely enclosed from grit and dirt, with no springs or loose parts, they're designed for long wear, extremely low maintenance cost. Made in four styles—standard pipe sizes from 1/4" to 3".

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The B. M. Root Company of York, Pa., makers of this Multiple Spindle Hydraulic Feed Wood Boring Machine, depend on Resistoflex hose for enduring performance of hydraulically operated clamps.

You needn't ever worry about feed-line fatigue as long as RESISTOFLEX hose is transmitting your hydraulic power. For RESISTOFLEX has *flexibility* and *fatigue resistance* to absorb continuous vibration—plus uniform, reinforced construction to withstand shock loads. On the above machine, for example, RESISTOFLEX hose assemblies sustain up to *60 load applications per minute!*

RESISTOFLEX hose is impervious to oils and hydraulic fluids because *compar,* of which its tube is made, is permanently unaffected by them. You can forget about clogging of mechanisms due to erosion—about impeded flow due to swollen hose.

If you have a problem in circulating anhydrous fluids, gases, or oils, get acquainted with the long-lasting, low-cost performance of RESISTOFLEX hose assemblies. Write today for details.

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Belleville 9, New Jersey

FLEXIBLE HYDRAULIC, OIL, GAS, VACUUM AND REFRIGERANT LINES. COUPLINGS AND FITTINGS

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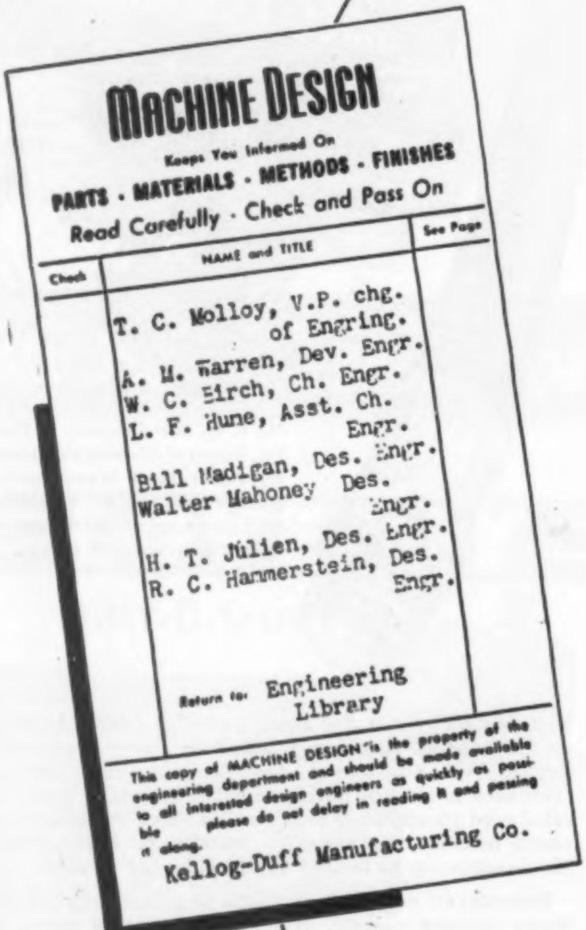

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WIRE FORMS · SMALL STAMPINGS

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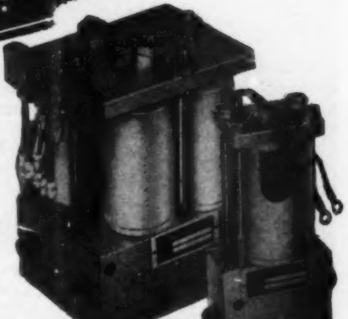
Two Plants for Spring Service · DETROIT 11, MICH. · ANN ARBOR, MICH.

NEW HIGH PRESSURE SOLENOID VALVES

- TWO-WAY
- THREE-WAY
- FOUR-WAY
- NORMALLY-OPEN
- NORMALLY-CLOSED



Features

- Rugged Compact Construction
- 3000 psi operating pressure
- May be mounted in any position
- Poppet design eliminates leakage
- Low current consumption
- Impregnated coils resist moisture and condensation

Waterman High Pressure Solenoid Valves are compact units that provide controls for hydraulic systems with pressures as high as 3000 psi. Poppet type construction eliminates leakage thereby making them ideal for clamping and holding cylinders or any other hydraulic application where internal leakage cannot be tolerated.

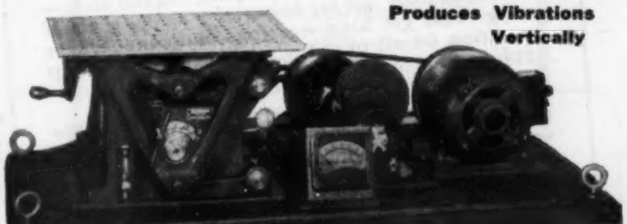
Available in ¼″ and ⅜″ pipe size—any voltage from 6 to 36 volts D.C.

WATERMAN ENGINEERING Company

725 CUSTER AVENUE · EVANSTON, ILLINOIS

Improve Your Product THROUGH VIBRATION Fatigue Tests

MODEL 100VA
CAPACITY 100 Lbs.
Produces Vibrations Vertically



YOU can definitely acertain how good your product is—substantiate construction and design—eliminate excessive material—through interpreting tests made on the All American Vibration Testing Machine. Eight models for handling parts or assemblies from 10 lbs. to 100 lbs. in weight. Models for vertical and horizontal movement of table. Vibration in simple harmonic motion. Standard machines produce frequencies of 600 to 3,600 v.p.m., manually or automatically controlled. Send for Catalog F. Special machines designed and built to meet your requirements.

ALL AMERICAN
Tool & Manufacturing Co.

1018 W. FULLERTON AVE. CHICAGO 14, ILL.

ENGINEERS
AVAILABLE OR WANTED

AVAILABLE: Mechanical engineer with 20 years of design, development and project engineering. Major experience on industrial hydraulic and pneumatic equipment, valves and motor-driven units. Have had supervisory and field experience. Handle tool and processing problems and established departmental procedure. At present employed. Will relocate. Age 45. Address Box 632, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

• • •

WANTED: Mechanical designer with a minimum of five years experience in heavy materials handling equipment. Able to do rapid, accurate design and detail work on ore bridges, cranes and whirlers. Write, giving resume of experience, education and salary desired. The Salary Personnel Manager, Dravo Corporation, Neville Island, Pittsburgh 25, Pa.

• • •

WANTED: Chief engineer. Must have experience in the mechanical press field. Should be capable of taking charge of the design and development of presses and other sheet metal working machinery. Reply by letter giving complete details as to age, education, experience, by whom employed, length of service, etc. All replies will be held strictly confidential. Niagara Machine & Tool Works, 683 Northland Ave., Buffalo 11, New York.

• • •

AVAILABLE: Graduate mechanical engineer. Registered. Professional. Successful. Administrative experience in design and manufacture of small internal combustion engines and special machinery. Qualified to act in capacity of chief engineer. Interested in employment in Chicago area. Address Box 635, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

• • •

WANTED: Design and product engineer. Mechanical or electrical engineers having design or product engineering abilities will find an opportunity in one of the several positions now available with long established concern whose products have world-wide distribution. Experience with the design of precise, electro-mechanical elements is desirable. Location is in upstate New York. Please include full particulars as to experience and training with your reply. Address Box 633, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

• • •

WANTED: Engineer—draftsman. Qualified to supervise the design and to follow up the building and erection of special heavy production machinery in insulating siding factory in middle west. Should have five years or more actual experience in special machine and conveyor design. College degree not necessary but desirable. Plant layout and material flow experience desirable. Address Box 634, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

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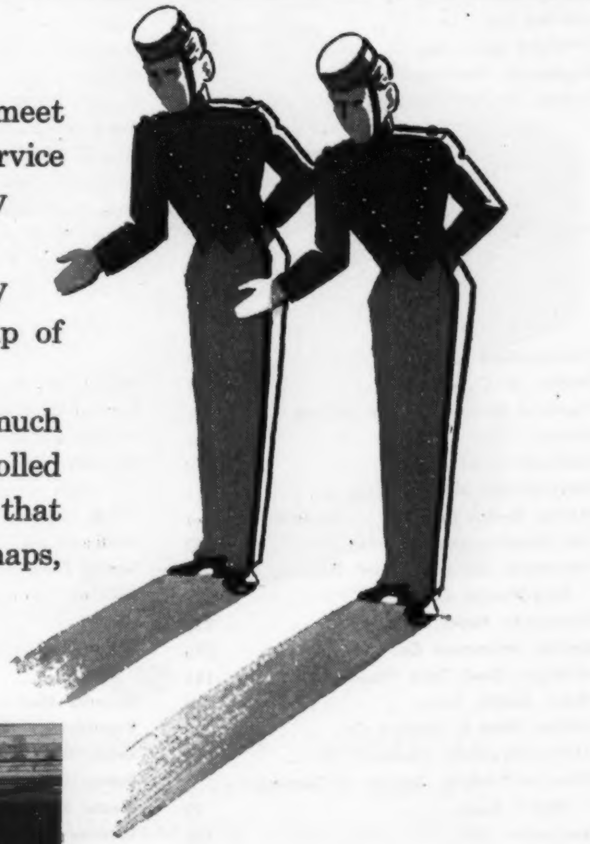
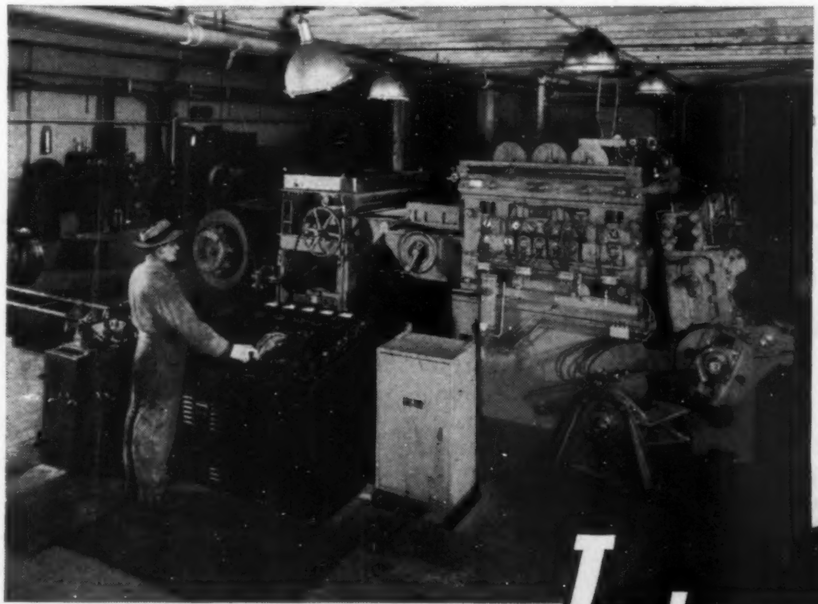
HE IS DOUBLY SERVED WHO GETS HIS STEEL, and GETS IT... when he wants it



International has helped many manufacturers meet their supply problems by providing dependable service in de-coiling, flattening, cutting, and pickling, or by coil slitting.

Here you will find such equipment as is used by the mills . . . the most modern, independent setup of this kind in the Midwest.

International — like everyone — has none too much steel. But, if you have available tonnages of hot rolled coil, International can process it for you on a basis that will assure a dependable, steady supply . . . and, perhaps, save you money. Ask about our service.



International's Flying Shear de-coils, flattens, cuts accurately to length. Coil slitter may be seen in background.

STEEL SERVICE INTERNATIONAL

International

ROLLING MILL PRODUCTS CORPORATION

5033 S. KEDZIE AVE., CHICAGO 32, ILL. **Phone HE 4-5200**

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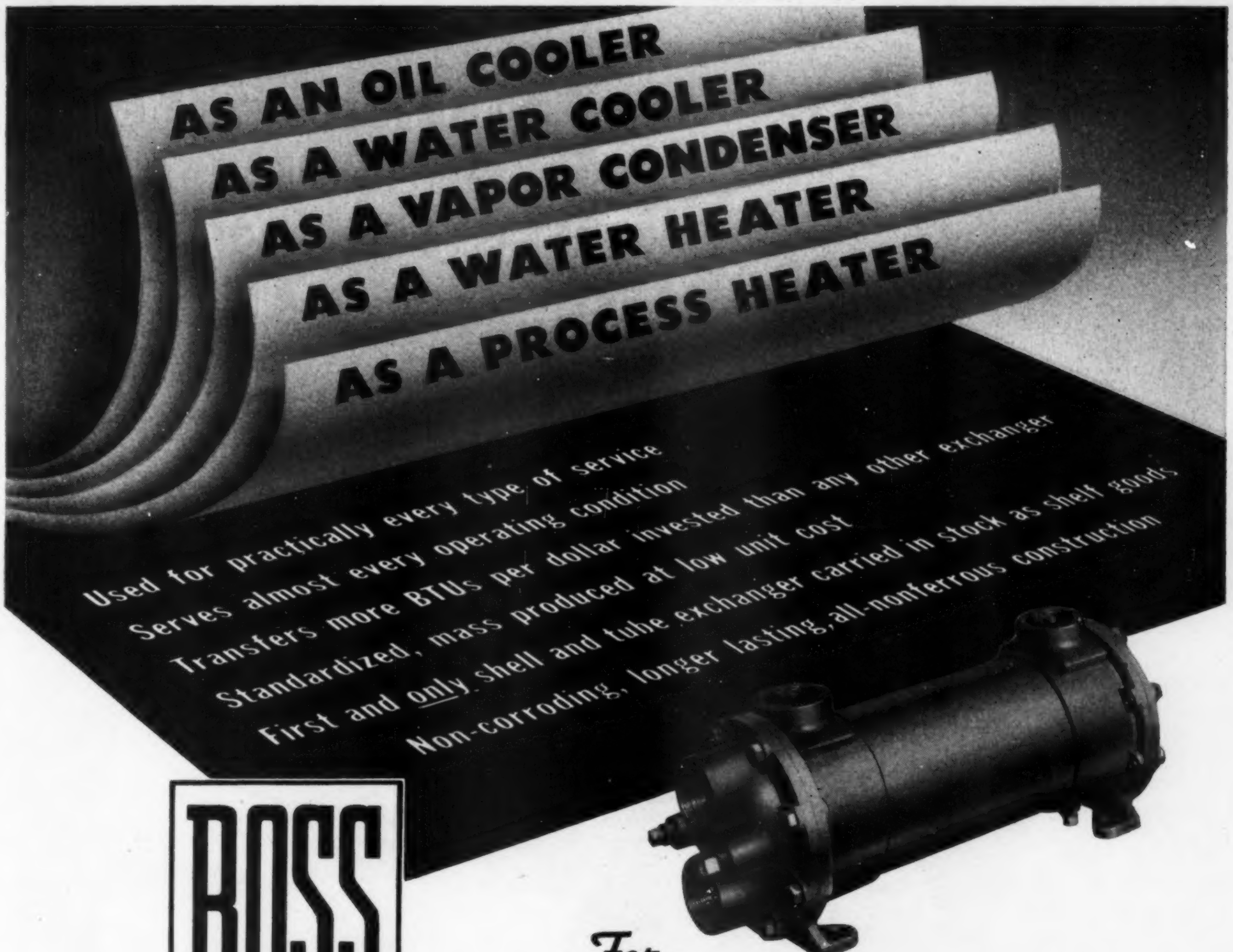

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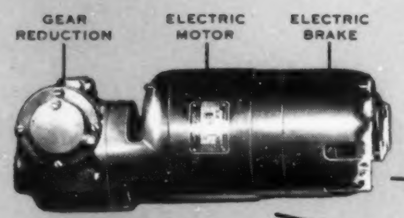
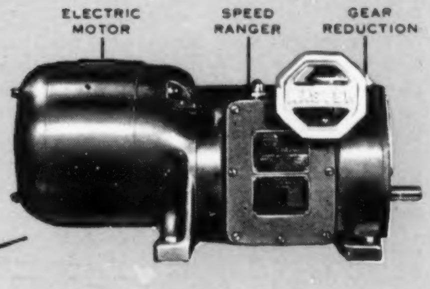
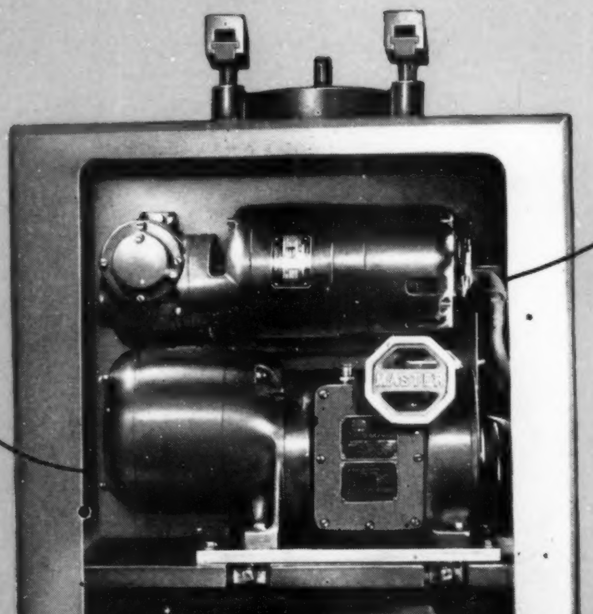




Easy does it



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Timken tapered roller bearings hold spindles rigid—keep them revolving accurately under the heaviest loads. Their tapered construction carries radial and thrust loads without deflection or end-movement and permits accurate preloading to any desired degree. Re-adjustment on the job is unnecessary due to "Generated Unit Assembly".

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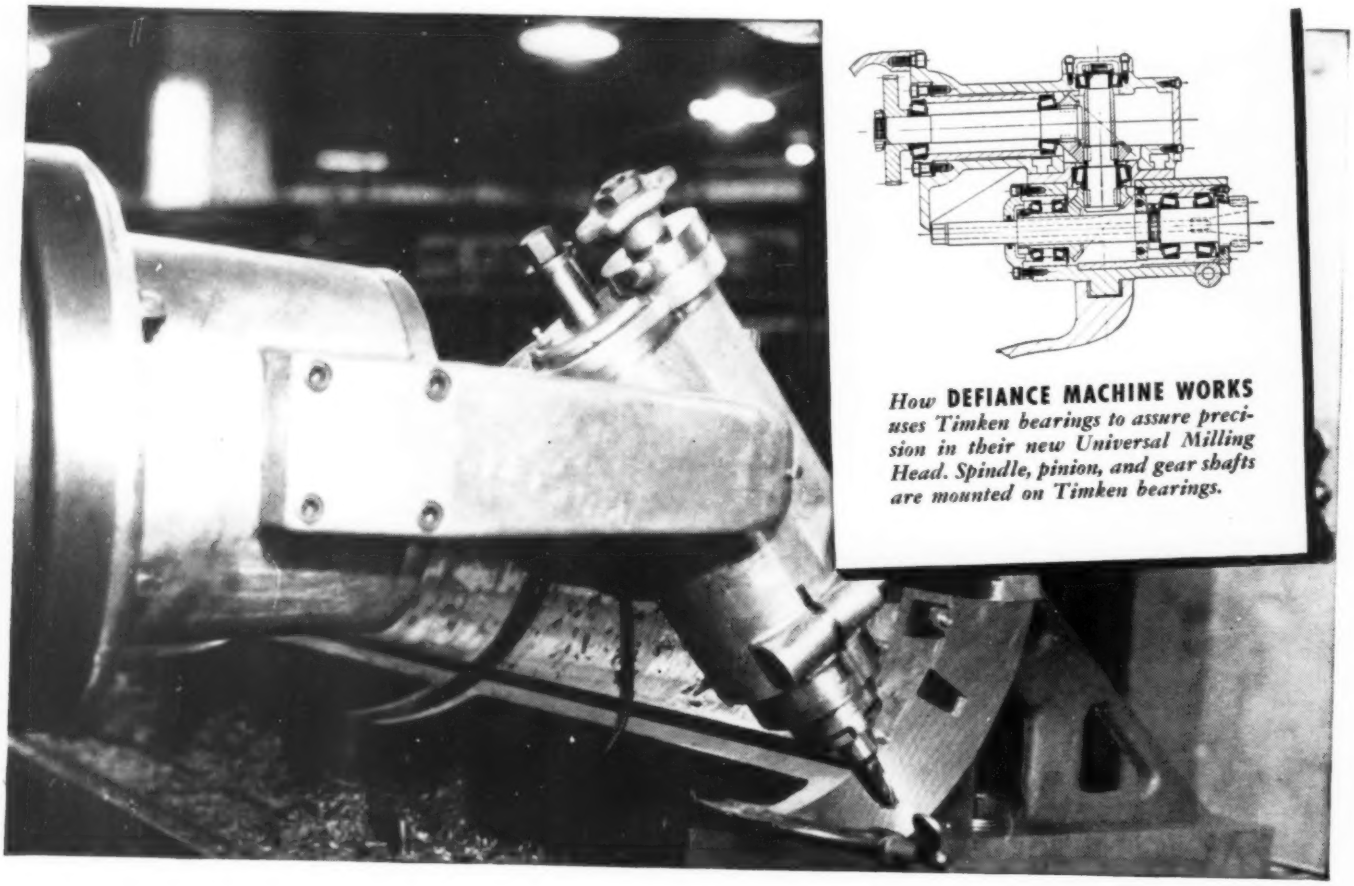
Remember that Timken bearings in your product add a valuable sales feature. They build greater acceptance for your product among customers. So always look for the trade-mark "Timken" on the bearings you buy. And when buying new machinery, be sure it's Timken-equipped. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



How **DEFIANCE MACHINE WORKS** *uses Timken bearings to assure precision in their new Universal Milling Head. Spindle, pinion, and gear shafts are mounted on Timken bearings.*

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TIMKEN

TAPERED ROLLER BEARINGS

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